Welding Engineer

PIONEER BUSINESS AND TECHNICAL JOURNAL OF THE WELDING INDUSTRY

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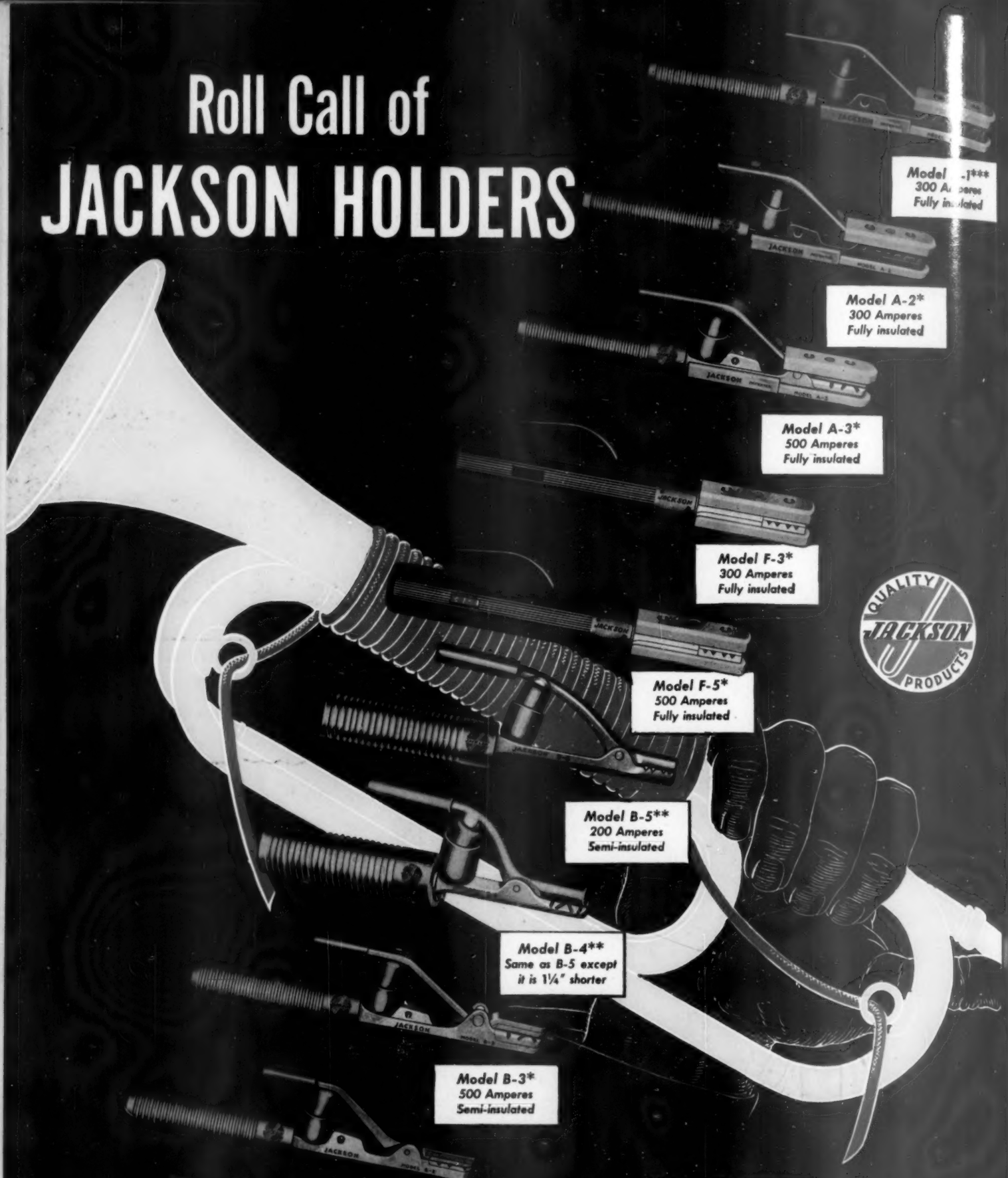

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IN THIS ISSUE

ARTICLES

X-Ray Testing of Welds 27
CLYDE B. CLASON

Pipes for Grand Coulee 32

Steam Tables to Order 34
C. R. FOSTER

Arc Welding Aircraft Tubing 35

Welded Circuit Breaker Tanks 38
WILLIAM A. SHELTON

Current Measurement—II 39
C. M. MANZER and H. S. DAY

Stainless Steel Tubing Fabricated 42

Buses and Trucks "Kept Rolling" 43

Welding Machine Maintenance 45
R. F. WYER

What's Here 13
Editorial 25
New AWS Codes 44
The Technical Slant 48
Brief Sketches of Welding Jobs 50
New Product Developments 52
Engineering Data Sheet No. 23 55
News of the Industry 58
Personals 59
Current Reviews 62
Recent Patents 63
Classified 75
Advertisers in This Issue 76

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The Welding Engineer

AMERICA'S PIONEER WELDING JOURNAL

AUGUST 1942

Established 1916

One Machine Not Needed

We are fighting a mechanized war. Our war machine is the result of the work of many types of machines. Mechanization has become an important part of our daily lives — our security.

Despite the importance of the machines there is one machine which we can easily do without — the political machine. A machine designed to smother democracy as effectively as an enemy tank. A machine run by a corrupt crew to control "yes men" having a rubber stamp where they should have brains.

To eliminate the political machine we must eliminate the brainless, rubber stamp political office holder!

Some people feel that it is a little early to talk of the coming fall elections. This is not the case; you have to start early to make most of the eligible voters realize there will be an election soon.

The person who fails to vote is frequently the one who complains the loudest about the way the government is run. The blame should not be placed wholly on those in office; it is also the responsibility of those who vote.

Fulton Lewis, Jr., MBS news commentator, in a recent broadcast on Congress and individual congressmen said ". . . When he (a Congressman) does not perform as he should perform, that is not the fault of congress. That is the fault of the Congressional machinery of self-government. That is the fault of only *you* and *me* for not paying enough attention to our business and self-government, to see that he is kicked out at regular election and that a good man is put in his place."

Remember these words for the next three months and we will see a change.

We are fighting to save democracy and one of the marks of democracy is a government "Of the People, By the People, For the People".

Let's keep it that way by eliminating incompetent political officials.

H. B. Jefferson

"MAN-HOURS"

—the misleading measure of production

It requires but one eye to see that man-hours alone are no measure of production. The thing that counts is how much that man can produce in one hour.

ALTER EGO: Sure. By one method he may produce two or three times as much per hour as by another method.

Take arc welding. This method results in far greater effectiveness. In joining steel, one welder does the work of two, three or four men using other methods. And he does a better job with 15% to 25% less steel.

ALTER EGO: Then it would seem a better measure for a company's contribution to the war effort would be METHOD-HOURS.

True as gospel. Our whole war production has been zoomed by those who grabbed arc welding as the only way to save our national neck.

ALTER EGO: And later they'll be schooled in an art to save their individual necks when competitive production again seeks profitable markets.

THE LINCOLN ELECTRIC COMPANY
CLEVELAND, OHIO

ALTER EGO: Literally, "one's other self"—the still, small voice that questions, inspires and corrects our conscious action.

then I said to myself—
IT'S METHOD-HOURS THAT COUNT!

X-Ray Testing of Welds

Lives of American fighting men will not be wantonly sacrificed through defective equipment as long as expert radiographers are on the job to spot troubles while the war gear is still in process of manufacture. No. 1 in a series on non-destructive tests.

By CLYDE B. CLASON

AN EXTREMELY large share of credit for the well known efficiency of American war production may be given to the comparatively new science of industrial radiography. A manufacturer of mobile artillery carriages, to cite but one instance, emphasizes that a good part of the speed at which carriages of an all-welded design are being produced can be directly attributed to the development of industrial X-ray equipment for weld inspection.

States this manufacturer:

"If this non-destructive method of testing welds had not kept pace with the progress made in the welding field, it would not have been possible to reach the perfection of design of the modern mobile gun carriage as rapidly as was done.

"Contrary to the belief that the time necessary to perform the X-ray operation slows production, we feel that it has the opposite effect because weldors, knowing that the work has to be X-rayed, are more careful in preparing and welding, and carefulness and accuracy of work go hand in hand with high-speed, first-rate production."

Back to the Past

Ironically enough, it was a German who discovered the X-rays now being employed in the inspection of war equipment destined to destroy thousands upon thousands of his later countrymen. In 1895 Professor Konrad Roentgen of the University of Wurtzburg, Bavaria, first observed the effects of X-radiation while passing an electric current through a vacuum tube. The Roentgen rays, as they were officially named after the discoverer, quickly became known as "X-rays" in the public mind because of their apparently mysterious origin and enigmatic qualities.

The field of usefulness found for the Roentgen rays in medicine is familiar to everyone and requires no comment. Industrial radiography lagged considerably behind medical applications; nevertheless, by the nineteen thirties it had begun to grow into a powerful production tool.

Pioneer Testings

One of the pioneers in the radiography of metal sections was H. H. Lester, senior physicist of the Watertown Arsenal, Watertown, Mass. Castings which were to be installed in the country's first 1,200 lb steam pressure power plant, that of the Boston Edison Co., were examined radiographically by Lester in 1924. Application of X-radiation to the inspection of welded joints of pressure vessels followed shortly. In 1930 the U. S. Navy specified that X-ray tests must be made of the main longitudinal and circumferential joints of welded boiler drums. Subsequently, the 1931 A. S. M. E. Boiler Code made X-ray examination of welded seams mandatory for power boiler drums and other pressure vessels designed for severe service conditions. Other code requirements soon followed.

Destructive vs. Non-Destructive

X-ray weld testing is now commonplace, the process being particularly well suited to butt-type joints where weld and parent metals lie in the same plane.

All weld tests may be classified into two basic types: destructive and non-destructive. Among destructive tests are tensile, shear, bend, nick-break, impact, fatigue, drift and crush tests. All of these have two major disadvantages:

(1) The sample or "coupon" is either destroyed or at least seriously strained during the course of the test.

(2) The sample may not be truly representative of the weld quality as a whole.

Neither of these charges may be laid against the X-ray method of weld testing. The rays penetrate the

Fig. 1—Relative positions of film, weld and X-ray tube in making radiographs of a high pressure vessel. The film is placed in close proximity to the welded joint being inspected.

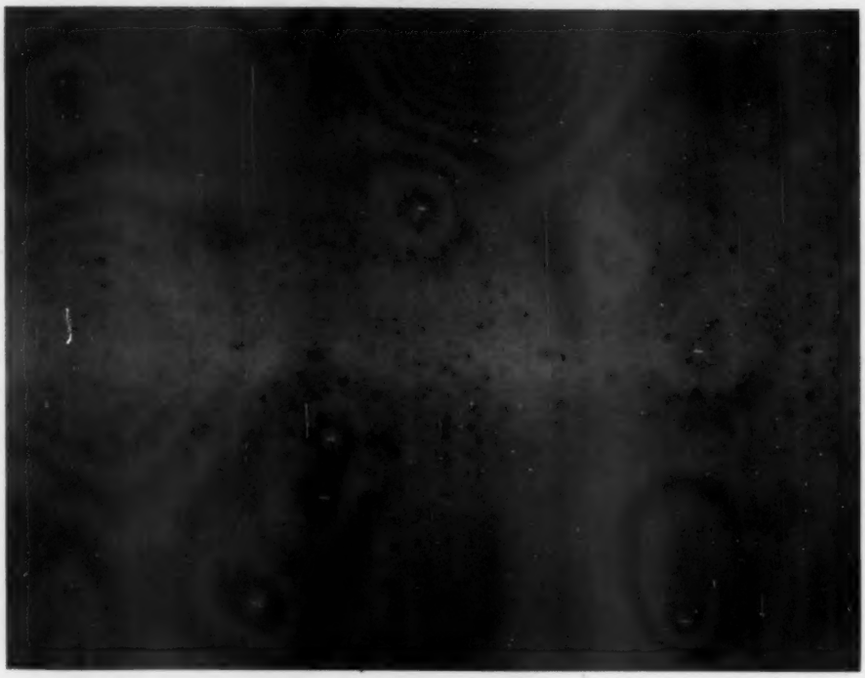


Fig. 2—A weld which would be rejected because of porosity (small dark spots). The larger light areas indicate spatter.

metal without harming it in any way, and the entire weld may be readily inspected. Only the comparatively high cost of radiographing (usually more per inspected foot than the total welding costs) has prevented the method from being universally employed. With the advent of high-powered X-ray equipment, however, the cost of examining thick welds has been materially reduced.

Fundamentals

X-rays are produced in an evacuated tube through the impact of a high-velocity electron stream upon a metal plate or "target" at the anode (positive electrode) of the tube. The electrons are "boiled" from the cathode (negative electrode) by means of a heated filament and are given their velocity by impressing an extremely high potential—on the order of hundreds of kilovolts—across the tube. X-ray voltages may reach as high as one million volts. The currents, however, are extremely low—usually on the order of 5 to 25 milliamperes.

Being much shorter in wave length than visible light, X-rays consequently possess the property of penetrating visually solid objects. They do not, however, penetrate all objects with equal facility but are absorbed to a degree depending upon the thickness and density of the material. Since density is a function of atomic weight, the heavier metals offer the greatest resistance to the passage of X-rays. Lead, a substance with the high atomic weight of 207.20, has a very high degree of X-ray absorption and so may be employed as shielding against these rays.

Like visible light, X-rays will travel in straight lines unless deflected. Therefore, the projected image of an object will be accurate in size and shape. When the image is recorded on film, it becomes a "shadow picture" dependent upon the thickness and density of each part through which the rays travel.

X-rays blacken a photographic film in much the same manner as does visible light. The print from the developed film is known as a radiograph, and the science of making and interpreting such photos is called radiography. A radiograph produced by X-rays is called an exograph.

The less dense regions of a weld offer the least resistance to the passage of X-rays. These portions, consequently, will show darkest when the weld is radiographed. Denser regions, offering greater X-ray resistance, will permit fewer rays to reach the film and hence will show as areas of comparative whiteness. This is the simple principle which permits the quick detection of weld faults. Such welding defects as porosity, slag inclusion, cracks, lack of fusion, gas pockets and blowholes all show up in radiographs as dark areas.

Fig. 1 shows relative position of film, weld and X-ray unit in making a radiographic inspection of a high pressure vessel. The tube head is at the center of the vessel for this examination, and the film is placed around the circumference in close proximity to the welded joint undergoing inspection.

Weld Defects

The common welding faults revealed by radiographs are—in order of frequency — porosity, entrapped slag, cracks and lack of fusion. The causes of these are well known to welding supervisors and are beyond the scope of this article.

Most important factor of any nondestructive test method is the ability of the inspector to interpret correctly the meanings of discovered defects. Only through careful study of many radiographs exhibiting known defects can such ability be gained. A number of exographs of typical defective weld conditions are included with this article in order to aid the reader in the identification of the more prevalent welding faults.

Porosity

Porosity usually (but not always)

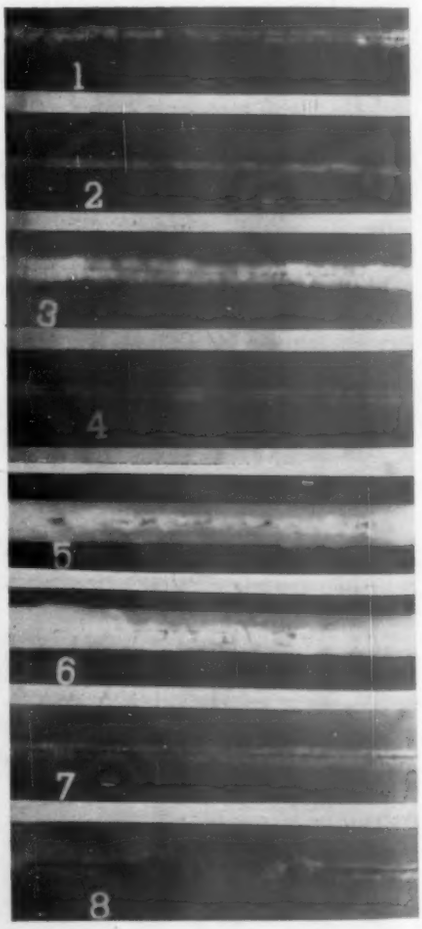


Fig. 3—Considerable entrapped slag is shown in No. 8 of this radiograph of eight welded joints in metal varying in thickness from ⅛ to ½ in. All of these welds are defective. Nos. 1, 2, 3, 4 and 7 show lack of penetration and gas inclusions. Nos. 5, 6, and 8 show lack of fusion.

appears as small, black circular spots. A certain amount of porosity is allowable in a weld; just how much is determined by comparing the radiograph with standard radiographs of acceptable welds.

Fig. 2 pictures a weld which would be rejected because of porosity. Note that the weld bead is perforated with dark spots, indicating a great amount of porosity well distributed throughout the entire weld. The areas in the weld bead showing degrees of light and darkness indicate the ripple effect of the bead. The large white spots adjacent to the weld reflect a condition opposite to porosity—namely, spatter. These spots appear as light splotches on the exograph because the rays traversing the spatter must penetrate a greater thickness of material before reaching the film.

Porosity of the small or "pinhole" variety may be seen in Nos. 3 and 4 of Fig. 4.

Slag Inclusions

Entrapped slag is shown in No. 8 of Fig. 3 and in No. 3 of Fig. 4.

Fig. 4—Four test samples cut from welded plates. No. 1 shows porosity and lack of fusion. No. 2 shows lack of fusion, lack of penetration and craters in the weld metal. No. 3 shows lack of fusion, pinhole porosity and slag inclusions. No. 4 shows fine porosity.

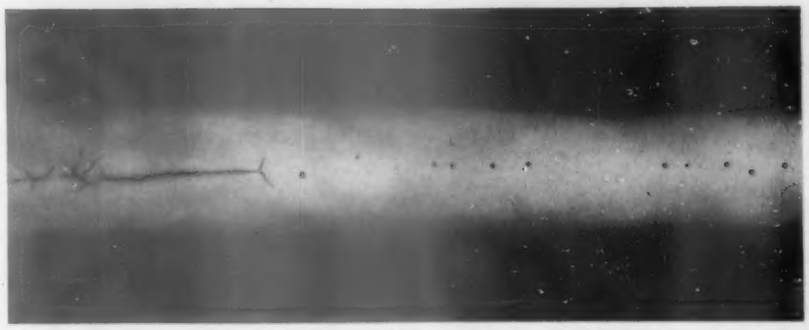


Fig. 5—Radiograph of a fusion arc weld with a severe crack and several minor branch cracks. Porosity is also indicated by the small round dark spots.

Slag is readily distinguished from blowholes because of its large and irregularly shaped shadows. It is often found extending parallel to a sidewall of the joint—a circumstance making for quick identification. Only a very limited amount of entrapped slag is permissible in acceptable welded structures.

Slag inclusions show as dark areas in ferrous materials but may appear as comparatively light streaks in metals of lesser weight. This is, of course, because the slag is of less density than the ferrous alloy but may be of greater density than the lighter-weight metal.

Cracks

Cracks appear as dark lines in the weld. Fig. 5 shows a severe crack with several minor branch cracks. This radiograph also reveals porosity, indicated by the small, round dark spots in the body of the weld. Note that both cracks and porosity are practically centered in the weld, showing that both of these defects may be close to the root of the weld.

Shrinkage and stress cracks may be readily distinguished by their appearance. Shrinkage cracks are generally irregular; stress cracks, regular and well defined.

Other Defects

Lack of fusion is usually easy to recognize as it has the appearance of a thin line of slag, or a crack, close to the joint wall. Examples of lack of fusion combined with other defects will be found in Figs. 3 and 4.

The four test specimens of Fig. 4 exhibit many of the defects which are common to faulty and careless welding. Sample No. 1 shows some porosity (dark spots) and lack of fusion. The latter is indicated by the fact that the edges of the plate are readily distinguished in the lower half of the weld.

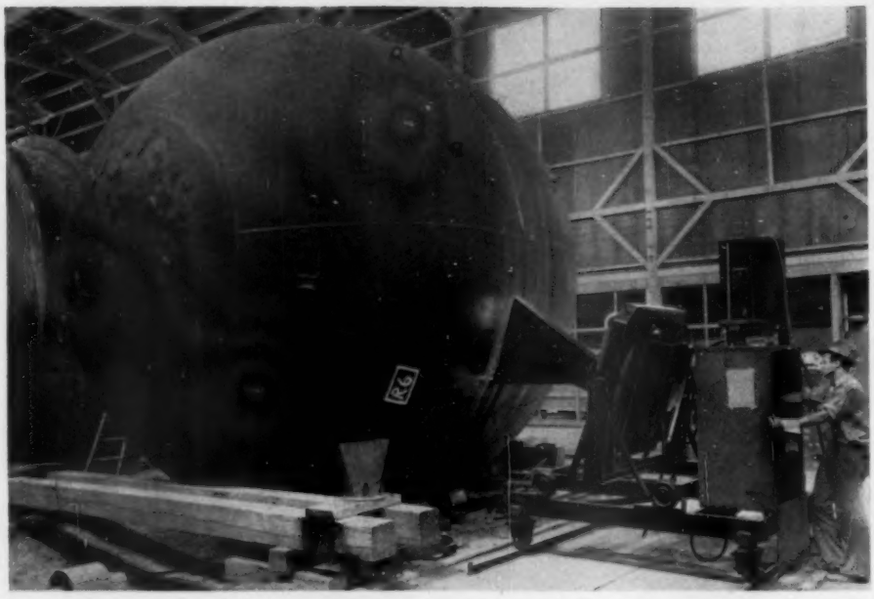
No. 2 of this figure pictures a poor weld with considerable lack of fusion and penetration, as well as several craters in the weld metal. Lack of fusion is indicated again in No. 3. There are also present slag inclusions and considerable pinhole porosity. An excessive amount of fine porosity is shown in No. 4. It should be also noted on No. 4 that the absorption of the weld metal (very white on radiograph) is much greater than the absorption of the base metal, indicating that this weld has a heavy bead reinforcement.

Just by way of contrast, Fig. 6 is a radiograph of a very good weld. Note its uniform density, as revealed by the nearly unvarying tone in the lighter area.

Locating the Defect

Since chipping is always used to remove unacceptable weld metal and is a much slower operation than welding, it is sometimes desirable to facilitate the task of the chipper by finding the exact depth and location of the defect. This may be done by double exposures.

Fig. 6—Radiograph of a very good weld.



In this method, exposures are made from two different angles on the same film or on separate films. The distances are measured between the two positions of the tube's focal spot and between each position of identification markers on the surfaces of the plate. Images of both the marker and the defect are projected on the film. By comparing the known distances and solving similar triangles, the exact location of the fault is readily found. Thus the chipper is enabled to begin his work on the side closest to the defect, and a minimum of weld metal will be removed and replaced.

X-ray equipment may also be used to investigate the properties of weld metals by means of diffraction patterns. These are produced by localizing a narrow beam of X-rays through a tube, passing them through pinholes, then through a small, thin sample of the material to be investigated. A film held behind the sample will show a dark central spot surrounded by a collection of rays, rings, spots, etc. This is called the diffraction pattern, and its analysis is of great importance in the steel and alloy industries where stresses and strains are a vital factor.[1]

Types of Equipment

X-ray equipment may be classified as portable, semi-portable and fixed. The first two types are those most commonly found in industrial plants, since it is generally preferable to take the equipment to the work rather than to take the work (which may be of the order of size of the enormous "sink stopper" shown in Fig. 7) to a special X-ray room. However, a "fixed" equipment is recommended in cases where the materials to be examined are of such nature that they can be readily transported to the X-ray machine, as full protection against X-radiation can then be provided.

Even very high voltage machines are now readily portable. The machine may be mounted either on a truck frame equipped with pneumatic tires as in Fig. 8 or on a car running on rails as in Fig. 7. Modern X-ray units are built to be both shockproof and rayproof. The high-tension equipment is usually immersed in oil, while the tube itself is enclosed with lead shielding except for the useful primary beam. The controls of the truck-mounted unit shown in Fig. 8 are housed in a lead-lined steel cab, providing complete protection for the operator.

Semi-portable equipment is described[2] as "a small enclosure in which is mounted the X-ray tube and all of its accessory equipment. Such a unit can be moved about from place to place by means of a crane or some similar device, but it is not continuously portable."

The million volt X-ray machine shown in Fig. 9 may be classified as semi-portable equipment. In a typical installation, the X-ray tube and transformer are supported on a carriage which traverses a track above the radiation pit where large pressure drums are examined for flaws. The carriage can be moved forward or backward, and the entire tube head may be raised or lowered for adjustment to any desired film distance. Lead protection 3 in. thick has been placed around the anode to absorb scattered X-ray beams. Further protection at the anode end of the tube is provided by a cone with a lead lining ½ in. thick. The controls are located in a room adjacent to the pit, which is entered from the floor level and may be reached only after traversing a maze with concrete walls 18 in. thick. Signal lights, both inside and outside the pit, are used to warn bystanders whenever this superpowerful X-ray machine is being operated.

Fig. 7—The portable 200 kv X-ray unit above is examining the welds of the 18 ft diameter "sink stopper" used to close off penstocks and pipe line at the Grand Coulee dam in Washington.

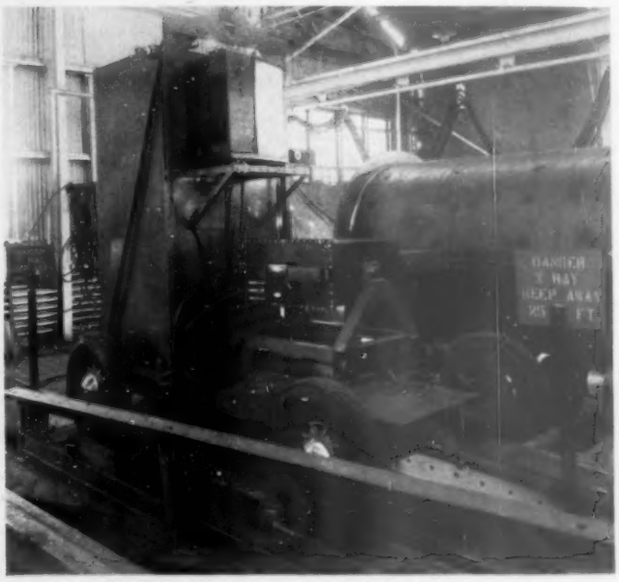


Fig. 8 (right)—A mobile X-ray unit, developed especially for welding shops, which permits examination of 3 in. rolled steel sections on a production basis.

Trend to Higher Voltages

The greater the potential across the tube, the greater the electron velocity and the greater the impact of the electron stream against the

[1]See page 615, tenth edition of *The Welding Encyclopedia*, and the article, "X-Ray Examination of Welding," beginning on page 39 of the May, 1942, issue of THE WELDING ENGINEER.

[2]Page 19, "Symposium on Radiography and X-Ray Diffraction Methods" published by the American Society for Testing Materials.

anode target. These high-velocity electrons result in the production of rays of shorter wave lengths and, consequently, increased penetrative power. Hence high voltages — or rather kilovoltages—are directly related to the increasing thickness of material which can be penetrated.

In 1918 steel of 1 in. thickness represented the absolute limit of X-ray penetration. As equipment manufacturers raised the potential across the tube, however, they increased the thickness of metal which could be examined radiographically. Table I, taken from the Westinghouse catalog of industrial X-ray equipment, shows the relationship between kilovoltage capacity and thickness and shows likewise how penetration also varies with the density of the material involved.

Steel penetration jumped to 4 in. and more as the kilovoltage capacities of X-ray generating equipment were raised from levels of 100 and 200 kv to levels of 300 and 400 kv. The 400 kv unit permitted penetration to a depth of 5 in. Only a very few years ago, 400 kv represented the maximum potential obtainable, but now a steadily growing number of million volt X-ray machines are in service, aiding the war program everywhere by making possible more rapid and accurate radiographs of heavy materials.

With the million volter, the required exposure time drops from hours to minutes. Steel of 4½ in. thickness, for example, can be penetrated in approximately 2 minutes. The maximum steel penetration (in practicable exposure time) stands now at approximately 8 in., but no one familiar with the history of X-ray equipment can believe that this will be the final word.

Contrary to what might logically be believed, a million volt X-ray machine is not particularly difficult to operate. In fact, some of those now in service in the country's war plants are being operated by high school students with little previous training in X-ray work.

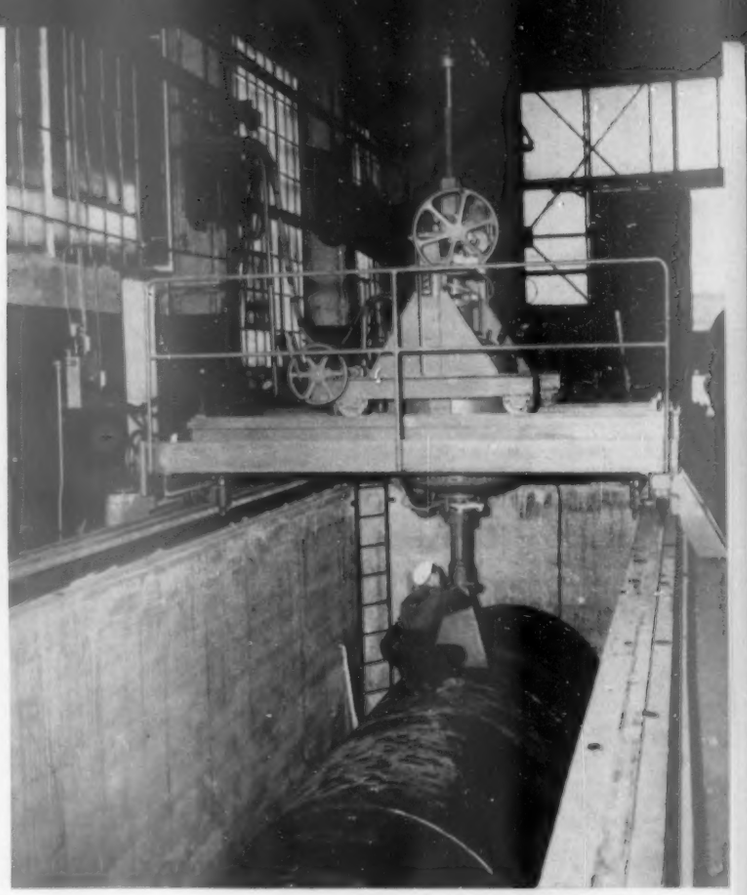


Fig. 9—The workman is positioning the tube head of a million volt X-ray unit in order to inspect the welds of the large pressure vessel in the radiation pit. This unit will penetrate steel plate to a practicable depth of 8 in. and will make radiographs which will show clearly any defects or imperfections greater than 2% of the depth of the weld.

When Are X-Rays Justified?

Its high cost is the one big objection to the X-ray method of weld testing. The film alone will run from 10 to 25 cents per foot—several times the welding cost of simple joints—and total X-ray costs may range as high as $1 to $10 per foot. Such large expenditures for testing cannot be economically justified for all welds and under all circumstances.

Whether to X-ray or not has always been very much of a moot question. The problem is largely an individual one, and a decision is to be reached only after careful consideration of the particular factors involved. However, a more or less general agreement has been reached on a number of points. It is held by practically every authority that radiographs are always justified in the first six of the following cases:

(1) For welded seams on vessels such as boilers which are to be subjected to high internal pressures. As previously noted, the testing of boiler joints was the first application of X-rays to weld inspection.

(2) For welds which have to withstand any kind of alternating forces such as reversed stresses, impacts, shocks, etc. An example would be the critical welds on welded girder bridges.

(3) For all welds of which failure would necessitate costly or time-consuming field repairs. Welds on stainless steels, the majority of which require heat treatment after welding, might be cited as one example in this category.

(4) For all welds of which failure might result in breakdown of the structure at a crucial period. Naval armament welds are an example. For this and many other kinds of war work, X-ray testing is required under rigid specifications developed by the U. S. Government.

(5) For checking the development of new welding techniques. Radiography will tell for certain whether or not the technique is performing as expected.

(6) For welded sections of objects that are to be given an expensive machine-finishing after welding. It is obvious that even a very slight defect in a part to be machined to a tolerance, say, on the order of 0.0001 in. might cause a good many man-hours to be wasted.

(7) For castings where there exists the possibility of defects that might be repaired by chipping and welding. Whether or not radiographs are justified in a particular case would depend upon factors such as the cost of the casting, its structural importance and the results which might follow a failure.

Table I. Thicknesses Which Can Be Examined Radiographically

(Data from Westinghouse)

Maximum Kv of Equipment	Maximum Thickness in Inches		
	Aluminum	Steel	Brass
85	3¾	½	⅜
100	4¾	⅝	½
140	7⅞	1½	1
220	12	3¼	2

* * *

Acknowledgment is made to the General Electric X-Ray Corp., Chicago, for permission to reproduce the photographs accompanying this article.

Pipes for Grand Coulee

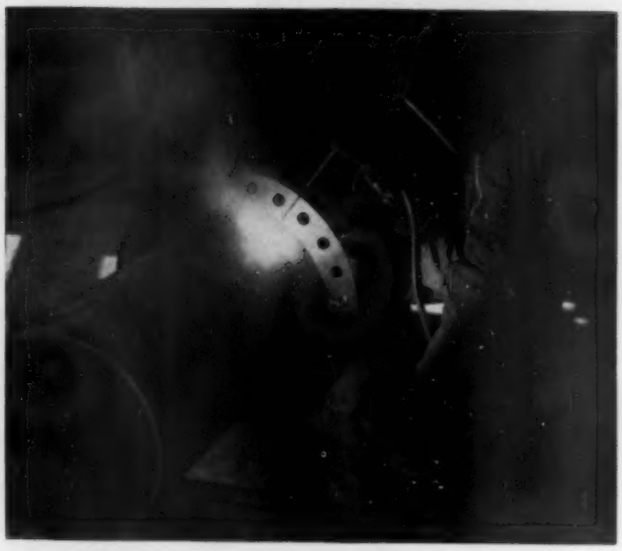


Fig. 1—Welding an 18 in. flange with coated electrodes.

★

Fig. 2—Flame cleaning a flange using a 2 in. flat tip torch.

★

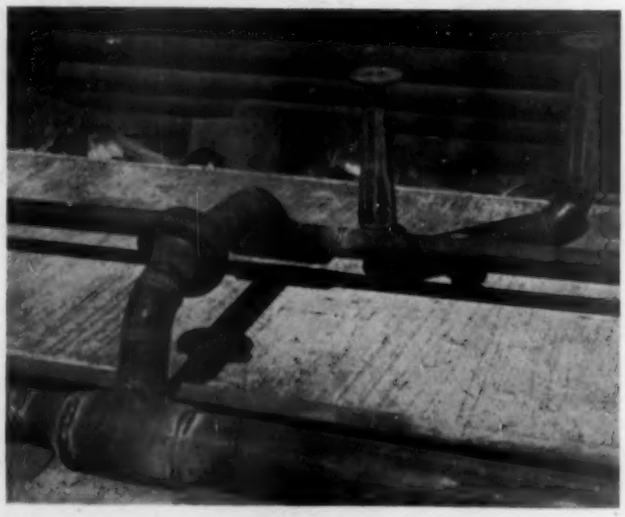


Fig. 3—Arc welded reducing headers. Fabricated U connection shown in background.

AN INTERESTING combination of various processes of oxy-acetylene cutting, arc welding, flame gouging and flame cleaning greatly facilitated piping installation at the mammoth Grand Coulee dam project, now under construction in the State of Washington by the U. S. Department of the Interior.

For Cooling Generators

The welding and cutting work to be described was for the shop fabrication of circular headers to provide cooling water for the plant's 108,000 kw hydro-electric generators. Some of the complicated assemblies which had to be worked out appear in the accompanying illustrations, all of which are reproduced through the courtesy of the Air Reduction Sales Co.

Fig. 1 shows the welding of an 18 in., 300 lb. working pressure, flange. These flanges were welded with 5/32 in., AWS E-6010 shielded arc type reversed polarity electrodes. Three beads were deposited on each weld.

Flame cleaning of all flanges and adjacent metal was required after welding in order to prepare the surfaces for painting. This was done with special flame cleaning apparatus (Fig. 2), employing a 2 in. flat tip.

Welding Reducing Headers

The same 5/32 in. coated electrodes used on the flanges were also utilized for welding of the compound reducing headers, Fig. 3. For this job, however, only two beads were deposited. In the background of Fig. 3 is a fabricated U connection employing two long transition

Ingenious combination of flame cutting and arc welding techniques speeds pipe fabrication at the Federal Government s big hydro-electric project to bring power to the Pacific Northwest.

Fig. 4—Fabricated bullheads and quarter ring headers of 8 in. pipe.

concentric reducers. These were also fabricated by welding. In this illustration, note too the eccentric shock fitting reducers and the welding tee.

Twelve in. bullheads of standard weight were fabricated as "orange peel" closures by means of a combination of arc welding and oxy-acetylene cutting. The bullheads are shown in Fig. 4, together with quarter ring headers of 8 in. pipe for 250 lb. service and 4 in. Van Stone flange connections (resting on the pipe). The detailed close-up, Fig. 5, shows how inlets for the 8 in. pipe were cut into the bullhead.

Coated electrodes, the same kind as on the other arc welding jobs, were also used for these bullheads, which serve to connect the ring header to the supply line.

★

Fig. 5—Close-up of bullhead showing inlet for 8 in. pipe.

★

Cutting Large Pipes

Pipe from 8 in. to 20 in. diam was readily handled by means of the pipe beveling machine appearing in Fig. 6. In this machine, cutting was accomplished by means of an oxy-acetylene flame. Machine is quickly adjusted to the pipe's diameter and traverses the circumference by means of rollers. There were two of these machines in service at Grand Coulee. Together they cut over 350 pieces of pipe.

Flame gouging equipment was used to remove the welds which the Department of Interior inspector rejected as unsatisfactory. Government inspection, incidentally, was thorough and rigid.

Ultimate plans for Grand Coulee call for the installation of eighteen 108,000 kw hydro-electric units, of which three are now in service.

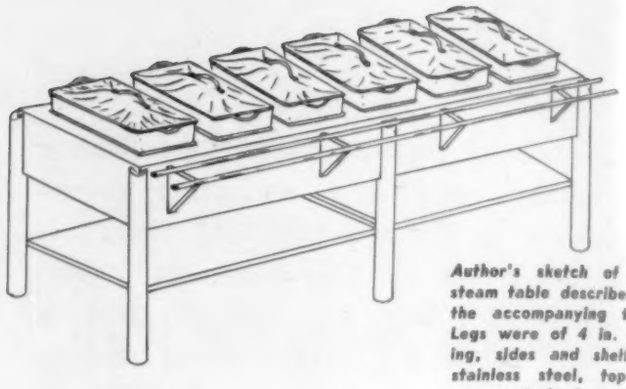
Fig. 6—Pipe beveling machine making bevel cuts on 18 in. diam, ⅜ in. wall pipe.

Photos Courtesy of Air Reduction Sales Co.

★ DESIGN

Steam Tables to Order

By C. R. FOSTER



Author's sketch of the steam table described in the accompanying text. Legs were of 4 in. tubing, sides and shelf of stainless steel, top of cast aluminum.

This weldor, temporarily a "guest" of a certain state institution it is not necessary to name, knows how to do a neat job of arc welding. He can also design.

THE Boss called me into his office one afternoon after I had been working in the sheet metal shop for perhaps ten or eleven months.

"Your name is Foster, isn't it? How long have you been a weldor?"

"Just about all my life." I was shaking in my shoes, for the Boss could be a stern man when he wanted to be. This time, though, he was just having some fun at my expense. A smile began to wipe out his frown, and I felt more at ease.

"You built the steam table for the front hospital, didn't you?" He went on without waiting for an answer. "Well, it would seem that job of yours started something! Mr. Cheek of the subsistence department has asked me to submit plans and prices for enough steam tables to switch the whole dining room over to the cafeteria system. He figures it will take eight tables."

Maybe it seems rather funny for an official of a penitentiary to be taking an inmate into his confidence like that, but I had come there as an expert weldor and had taken hold, so to speak.

"Make some sketches," he told me. "And they had better be good, too."

All that afternoon and evening I did nothing else but make sketches. The next morning I presented a plan, which, boiled down, would save nearly $200 on each table. After making a few minor changes, they told me to go ahead with two tables.

A Stainless Steel Job

The hospital table had been built of rolled aluminum and Monel metal, but these for the dining room were to be made primarily of stainless steel, with tops of cast aluminum.

The tables were to be 9 ft 6 in. long, 31 in. wide and 10 in. deep. Each would have six legs and a shelf, 10 in. from the floor, to act as a brace for the legs in addition to serving as a shelf. The top was to be in six sections (see sketch) and fitted with six oblong removable kettles and lids.

The kettles would hold approximately 12 gal each. Five were to be in a hot water compartment and one in a cold compartment. Because the cold compartment was to accommodate ice, it had to be insulated from the hot compartment by a double partition with a dead air space between.

All in all, these tables would be a great improvement over the old system for feeding our nearly 4,000 inmates. They would pay for themselves in food savings, Mr. Cheek figured, besides serving hot, more palatable food.

Legs Sawed from Tubing

While we were waiting for the material to arrive, I gathered up some lengths of 4 in. boiler tubing for the legs and had the lathe man take a skin cut off them. The corners were then sawed out in V-shape to fit the corner of the tables as they were welded. There was some activity around the shop, I can tell you, when the rest of the material finally came! There was plenty of work—and even some headaches—before those two tables were finally finished.

Stainless steel welding presents a number of problems to the man responsible for the work. Our steel was an 18-8 alloy, $\frac{3}{32}$ in. thick. We used stainless steel electrodes of the same size and quality. Some of the parts which we were to weld on to the main body were pre-fabricated and arrived all buffed to a mirror finish.

His Own Solution

I didn't want to spoil that finish, but how to keep from doing it was one of the headaches I have mentioned. We didn't have any non-splatter solution, so I set out to find a way to make something work that we did have. After a little experimenting, I hit it right on the head! Parting dust from the foundry, mixed to a thin paste with common lubricating oil, makes a good non-splatter solution. The oil does not flash but burns away slowly, leaving the parting dust as a residue which can be easily wiped off with a cloth after the weld has been completed.

I had two student weldors working with me most of the time. Together, the three of us turned out a job that any well equipped shop on the outside would have been proud to claim. The tables were held up by the authorities as a shining example of the work done by our department, and they told us to go ahead with the others. To date, four have been finished, and the material for the remaining four is on order.

Yes, business is always good in our little shop. Drop in and see us sometime, but don't stay too long; it gets monotonous.

Arc Welding Aircraft Tubing

Thin-walled chrome-moly tubing used to be considered difficult to arc weld. To lick the Axis, though, the U. S. aircraft industry had to learn how to weld such tubes on a production basis. Here are pointers on how this job may be successfully accomplished.

THE MODERN airplane is largely a hand-made metallic structure containing a number of members of varying size and weight. An extremely complicated structure, with a multiplicity of joints, the airplane must be light in weight yet sufficiently strong to withstand the severe service of usage. Naturally, it is difficult to manufacture.

Of the many metal-joining processes available to the aircraft industry, welding is obviously the most practical. It is only the welded joint that offers: (1) rigidity, (2) simplicity, (3) low weight, (4) full strength joints, (5) low corrosion possibilities and (6) low cost production equipment. As a consequence of these many advantages, welding has been universally adopted and is now playing a vitally important role in the building of trainers, fighters and bombers for our armed forces.

Tubes Form Skeleton

Basically, the aircraft fuselage is an assembly of thin-walled tubes welded in clusters to form a rigid trusslike structure. Even with the stress-skinned monocoque type of fuselage of our heavy bombers, welded tubular motor mounts, landing gear structures and similar parts are employed.

Chrome-moly (SAE X-4130) steel tubing is generally used because of its high strength-weight ratios. A chrome-moly tube, with tensile strength in a range of 95,000 to 200,000 psi, is two to three times as strong as a carbon steel tube of the same weight. From a purely welding standpoint a very nice feature of SAE X-4130 is its air-hardening properties. This means that the heat of welding will not result in more than a 10% decrease in strength in the heat affected zone.

The tubing supplied to military aircraft manufacturers must conform to the following Army and Navy specifications:

Carbon	0.27-0.33%
Manganese	0.40-0.60%
Chromium	0.80-1.10%
Molybdenum	0.15-0.25%
Phosphorous	0.040 Max.
Sulphur	0.045 Max.

These specifications also limit grain size to size 5 or finer. As is well known, "fine-grain" steel may be welded with much greater facility than "coarse-grained" steel.

In general, chrome-moly steel is readily weldable. Unless welded to other steels, such as forgings, with a higher content of carbon, it does not require heat treatment after welding.

The most recent development in aircraft construction has been a trend toward arc welding of chrome-moly

Fig. 1—Arc welding a motor mount in jig. All material except forgings is chrome-moly steel tubing with wall thicknesses on the order of 1/16 to 3/32 in.

tubing. This material may be welded with either a mild steel electrode or with an electrode of special alloy for chrome-moly steels. In either case, the electrode should be heavily coated in order to shield the arc.

Use Lower Currents

Aircraft arc welding usually requires somewhat lower currents than are customarily employed. This means that generators must be designed to eliminate the difficulties ordinarily associated with low amperage: insufficient penetration, irregular arc, electrode freezing when arc is struck, sputtering, loss of arc control, etc.

The problems encountered in building military aircraft are many, and the manner in which they have been overcome would be highly interesting to readers of THE WELDING ENGINEER. Unfortunately, that story would also be equally interesting to our country's enemies. For this reason, the details of arc welding of aircraft presented here will be confined to component tubular parts of monocoque aircraft structures.

The accompanying illustrations show various plane parts undergoing welding operations at a large west coast aircraft plant.

Welding a Motor Mount

In Fig. 1, a weldor is seen arc welding a motor mount; note the jig. Two completed mounts are shown in Fig. 2. The motor mount is one of the most vital parts of an airplane; a motor mount failure may well mean the loss of an expensive plane and its highly trained crew. Consequently, the welding operations are worth considering in some detail.

Arc welding motor mounts calls for skill on the part of the weldor. It is not an easy task to join thin-walled chrome-moly tubing — tubing with walls $\frac{1}{16}$ to $\frac{3}{32}$ in. thick—without burning. As may be seen from Fig. 2, eight tubes are to be assembled into four V-shaped legs which will join a ring at the open end of the V. At the foot, or point of the V, there is welded a drilled forging which provides a means of connecting the motor mount to the fuselage.

Welding the Legs

The motor mount is fitted with four legs, V-shaped as previously stated, each composed of a pair of tubes. The legs are formed by assembling a pair of tubes in a jig and welding them to each other. Since each leg is slightly different, four jigs are required, one for each leg. The angle is located by vee blocks, and the tubes are held with clamps while the web of the forging, previously shaped to wrap around the outside of the tubing, is welded along the edges.

The welding is done with the machine set at 20 volts across the arc, 100 to 115 amp. Shielded arc type electrodes are used, $\frac{1}{8}$ in., either of mild steel or alloy for chrome-moly steel. The welded legs are given stress relief heat treatment at 500 to 600 F and allowed to cool in the jigs.

Heat treatment is necessary because of the difficulties involved in the welding of tubing to forging. One of these is that the forging generally has a rather high carbon content, which means a likelihood of a "brittle" weld with a tendency to crack. A second difficulty is that, in order to increase the machinability of the forging, sulphur and phosphorus content is also kept on the high side. This increases the chances of porosity due to gas formations below the surface of the weld.

A third difficulty is that the forging may have a lower melting point than the tube. Finally, as a result of the forging and perhaps machining processes previously undergone, the forging may have locked-up stresses which will subject the welded joint to strains resulting in fracture.

Ring and Ring Forgings

The ring forgings (motor mount lugs) come to the weldor in halves and must be welded together prior to assembly on the ring. This job offers few diffiulties and requires neither preheat nor stress relief. A $\frac{3}{32}$ in. electrode is used, and the welder is set at 20 volts across the arc, 75 amp. The halves of the forging are held in place and against each other in a jig. Care must be

Fig. 2—Completed motor mounts. Note how the V-shaped legs are joined to each other and note gusset reinforcements on the tubular ring.

taken to keep them in line during welding.

The ring is made from a tube which is cold rolled into the desired circumference by power rolls. The ends are cut to form a long splice for welding, and the ring is placed in alignment in a jig. The splice is tack welded and okayed by an inspector before final welding. Outside of tack welding, this ring is the only part of the motor mount that is welded by the oxy-acetylene process at this plant.

Forgings are now welded to the ring in a jig which can be revolved to permit the weldor to do most of his work in the flat position. For this job, ⅛ in. mild steel coated electrodes are used, at 20 volts across the arc, 120 amp. Preheating is done at 250 to 350 F and stress relieving at 500 to 600 F. The ring is left in the jig to cool.

Ring Welded to Legs

The welding of ring to legs is done in the main assembly jig, which is mounted on a bearing and may be rotated to bring most of the work into the flat position. After ring and the previously welded legs have been assembled in this jig, they must be approved for fit-up before welding. As in former operations, preheating is done at 250 to 350 F. To minimize distortion, skip welding is employed so that after a tube has been welded to the ring the one opposite it is the next to be welded.

The gussets are tacked in by an oxy-acetylene torch, which makes small, neat tacks that are easily absorbed by the arc. After tacking, the gussets are inspected and approved for welding. Here, the welding sequence is important. The gussets on the outside of the motor ring must be welded first. They are divided into groups. After one group is done, the group directly opposite is next welded. No welding on the inside may be done on the gussets until after all groups of outside welds have been completed. Essentially the same welding order is followed for the inside.

For welding the gussets, a $\frac{5}{32}$ in. mild steel coated electrode is used. The potential across the arc must be from 20 to 25 volts and the current from 100 to 120 amp. Preheating is done at the previously mentioned temperatures of 250 to 350 F and stress relieving at 500 to 600 F.

The mount is cooled in the jig, checked for trueness after removal and then put into a drill jig for drilling and reaming of the bolt holes in the feet. After this operation, it goes to the machine shop.

Other arc welded parts of the airplane fuselage may be seen in Figs. 3, 4, 5 and 6.

Fig. 3 shows fulcrums of landing gears which were welded without heat treatment. Tubes were of chrome-moly steel with ODs ranging from 2½ to 4½ in. and wall thicknesses from $\frac{1}{16}$ to $\frac{5}{16}$ in. The landing gear assembly with cowling in place is shown in Fig. 4.

The group of struts in Fig. 5 were also arc welded from chrome-moly steel without heat treatment. Tube ODs ranged from 1¼ in. to 2 in. and wall thicknesses around $\frac{1}{16}$ to ⅛ in.

Another view of the welded landing gear assembly is given in Fig. 6.

Fig. 4—Landing gear assembly; cowling in place.

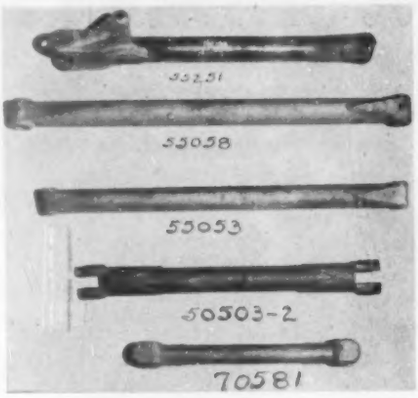


Fig. 5—Struts formed by arc welding chrome-moly tubing.

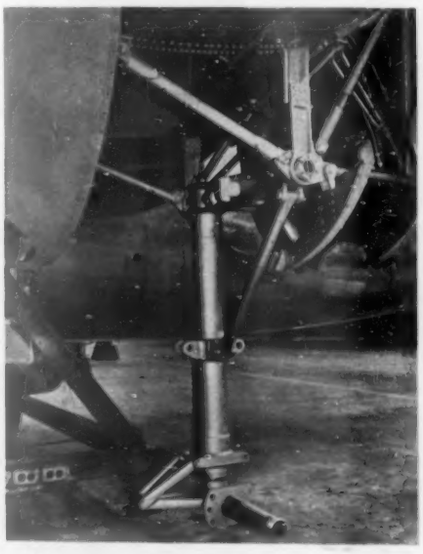


Fig. 6—Arc welded landing gear assembly.

Fig. 3—Fulcrums of landing gears. Though arc welded, these did not require heat treatment.

Acknowledgment is made to The Lincoln Electric Co., Cleveland, for the photographs reproduced on this and the opposite page.

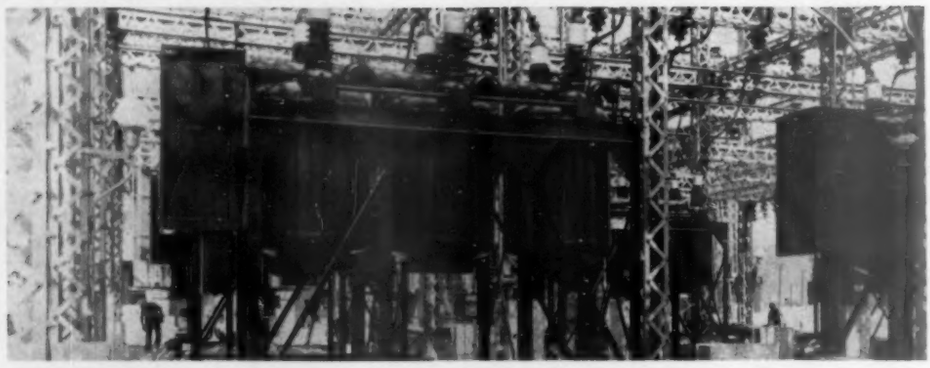


Photo by Hobart Bros. Co.

Steel plates were shaped for the shells of these large oil circuit breaker tanks, installed at a Los Angeles power station. After outside of a longitudinal seam had been welded by automatic arc, inside of seam was welded manually. The same combination of automatic and manual welding was employed for tank bottom.

Welded Circuit Breaker Tanks

Through welding, strong steel tanks for 1,500,000 kva oil circuit breakers were fabricated in less time and at less cost than circuit breaker tanks of cast iron.

By **WILLIAM A. SHELTON**

Mechanical Engineer, Bureau of Power & Light, Los Angeles

THE BEST features of automatic and manual arc welding were combined in a technique developed for the fabrication of 12 tanks for 34,500 volt, 1,500,000 kva outdoor oil circuit breakers at a plant of the Los Angeles Bureau of Power & Light.

The steel plates for the tanks were required to meet ASTM specification A-7-39 for structural steel in bridges and buildings. According to these ASTM standards, these plates had to have a tensile strength of 60,000 to 72,000 psi with a yield point of 0.5 of the tensile strength and in no case less than 33,000 psi.

Bevel for V-Groove

The plates making the tank shell were cut and beveled for a V-groove by oxy-acetylene torch. The outside of the longitudinal seam was welded automatically with a one pass weld. Then the inside of the seam was chipped to clean the base of the weld so that it could be inspected. This, obviously, turned the groove into a double-V.

After chipping had been completed, the seams were ready for the final welding operation. This weld was a single pass, manual arc application with a $\frac{1}{4}$ in. mild steel electrode.

The bottom was shaped by flame-cutting and tacked to the shell. If the fit passed inspection, the bottom was welded automatically to the shell with an outside girth seam. The inside of the seam was chipped to clean metal and, after visual examination, manual welded with a multiple pass weld.

Test Procedures

Welding was checked closely by test bars, radiographs, and visual examination. Test bars on the longitudinal seams were continuations of the regular welds while those of the girth welds were made separately. Table I gives the results of the tensile and free bend tests. These tests were all satisfactory and well within the limits specified by the ASTM code.

Radiographs were made of welds on selected sample tanks. A weld showing defects was chipped out, rewelded and again radiographed. After rewelding, the tank was stress relieved by heating to and holding at 1,200 F for 1 hr per in. of plate thickness and then cooling gradually over a period of 6½ hr.

All tanks were subjected to a hydrostatic test of 150 lb for 5 min, and in addition hand hammer blows were applied to test the strength of the tank and show up any bad welding. Finally, each tank was sand blasted and painted.

These welded steel tanks were lighter than cast iron and were also produced more quickly and economically. The welding was done by the Southwest Welding Co., Alhambra, Calif.

Table I. Tests of Welded Tank Seams

			TENSILE TESTS		FREE BEND TESTS				
Tank	Seam	Section	Y.P. psi.	T.S. psi.	% Elong.	Fracture	Hand	Automatic	Nick Bend
4	Girth	Reduced	53,340	69,370	24.5 (2")	Weld	33	33	OK
6	Longitudinal	Full	39,030	61,850	19.4 (8")	Plate	50	39	OK
18	"	Full	40,730	64,220	18.1 (8")	Plate	67	39	OK
25	"	Reduced	52,870	69,230	24.5 (2")	Weld	44	24	OK
36	"	Full	38,620	62,700	16.9 (8")	Plate	59	36	OK

Current Measurement Improves Welding Technique

By
C. M. MANZER and H. S. DAY
General Electric Co.

Part I, published in the July issue of THE WELDING ENGINEER, *discussed instruments for and methods of measuring current flow during resistance welding operations. It was disclosed how slight variations in current valves will materially affect weld results.*

★*Part 2—Intimate knowledge of current requirements in resistance welding operations will result in more efficient use of existing equipment. Accurate current measurement and card records will provide the information that is needed.*

IN NORMAL operation, the flow of weld current in resistance welding is only a few cycles in duration. For this reason a pointer-stop ammeter, either portable or switchboard type, is the most suitable for measuring resistance welding current.

The switchboard ammeter scale may be marked in terms of welding transformer primary current, or directly in terms of secondary amperes, if the ratio of transformation is constant. If heat adjustment is by means of taps, the ammeter scale is usually marked in primary amperes, and the secondary current obtained by multiplying the ammeter reading by the ratio of transformation for the particular tap being used.

Determining Ratio of Transformation — The welding transformer ratio of transformation may already be known, or may be determined as follows:

1—VOLTAGE METHOD

Measure simultaneously primary and open circuit secondary voltages. Then—

$$\text{Transformer Turn Ratio} = \frac{\text{Primary Voltage}}{\text{Open Circuit Secondary Voltage}}$$

If the transformer does not[1] saturate under welding load, and the exciting current is small, for practical use the ratio of transformation will be the same as the turn ratio. Obviously, if the welding transformer has several taps, the ratio should be determined for each tap. Once the ratios are determined, they remain constant, and can be used for all future work.

2—CURRENT METHOD

An alternative method is to measure primary current and secondary current simultaneously.

$$\text{Ratio of Transformation} = \frac{\text{Secondary Amperes}}{\text{Primary Amperes}}$$

If the welding electrodes are provided with proper water cooling, and the control will permit the welding current to flow for 1½ seconds or more, the primary and secondary current may be measured with conventional instruments. If this is not

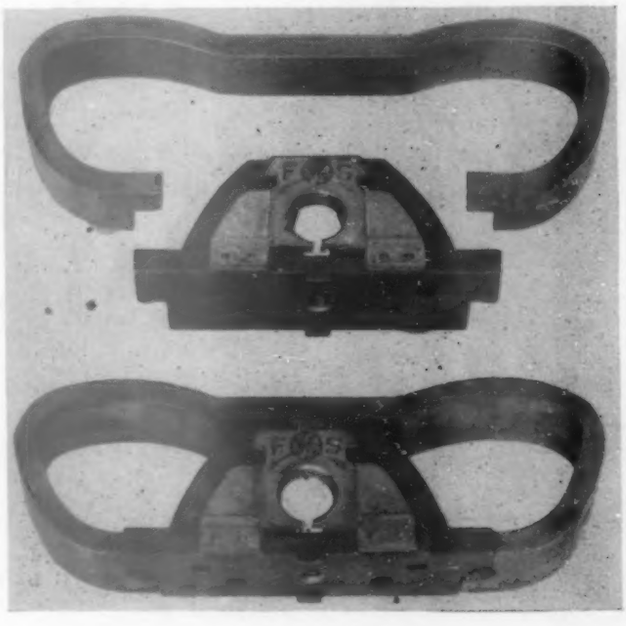


Fig. 6—Welded magnet assembly for watthour meter.

[1]An investigation by our transformer department has shown that welding transformers of usual design, operating at normal voltage, do not saturate under load, although the core flux density may be fairly high. Even under these conditions, the exciting current is not likely to be over 2%, which is usually negligible.

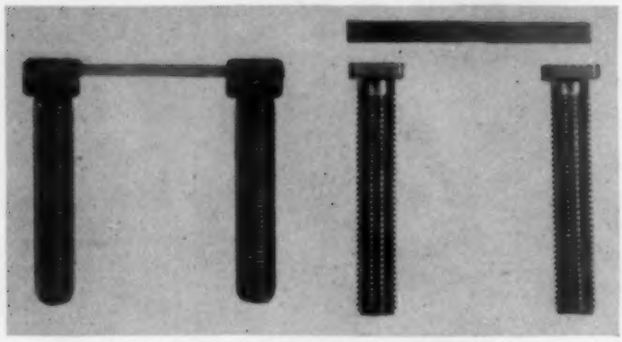


Fig. 7 — Brazed shunt assembly for electrical instrument.

the case, pointer-stop ammeters may be used.

The determination of transformation ratio by the current method has the disadvantage of requiring a high capacity current transformer for the secondary circuit, and possibly the use of pointer-stop instruments, or an oscillograph, if the welding current cannot be left on long enough to get a steady reading with usual instruments. However, the current method may be more accurate since it takes into account exciting current and any tendency to saturate. Again, the ratio should be determined for each tap, if this form of heat control is employed.

It was desired to equip a standard No. 1 press welder, provided with a 50 KVA transformer, with a switchboard type pointer-stop ammeter. The procedure was as follows:

(a) Primary and secondary voltages were measured simultaneously with standard A-C voltmeters.

Primary voltage = 465 v.

Open circuit secondary voltage = 7.26 v.

Ratio of transformation =

$$\frac{\text{primary volts}}{\text{secondary volts}} = \frac{465}{7.26} = \frac{64}{1}$$

Since heat variation was by phase control, only one ratio measurement was necessary.

(b) With minimum loop area, measure maximum and minimum primary current.

Maximum primary current=500 amp.

Minimum primary current = 62 amp.

These measurements were made with a portable pointer-stop ammeter and split core transformer.

(c) A standard switchboard current transformer rated 250/5 amp., 50/1 ratio, was selected since the duty cycle was only about 10%, and mounting space was limited. Under this condition the transformer can be used up to 500 amp. in the primary, with corresponding secondary current of 10 amp. (If the duty cycle had been high, as in seam welding, a 500/5 amp. transformer would have been chosen, due to heating in current transformer).

(d) A switchboard type ammeter with a double rated current coil, 0-5 and 0-10 amp., was selected. The overall multiplying factor is—

Welding transformer ration × Current transformer ratio or—

$$\frac{64}{1} \times \frac{50}{1} = 32{,}000 \text{ to } 1$$

Thus the ammeter full scale value is 16,000 amp. for the 5 amp. coil, and 32,000 amp. for the 10 amp. coil. This allows readings to be taken from 6,000 to 32,000 amp., with an accuracy of approximately 5% of full scale value for "on" times of 3 or more cycles. At slight sacrifice in accuracy, readings below 6,000 amp. can be made.

Power Supply Need

The users of resistance welding equipment are rapidly recognizing the need for an adequate power supply. With the welding transformer de-energized, the line voltage is no indication of the ability of the circuit to provide the needed power. Actual installations have been found where the line voltage drops 55% when the welder is operated. For consistent results, the total variation in supply voltage should never exceed 10%.

Probably the most common cause for inadequate power supply is the lack of accurate information on the KVA required by the welder. The actual KVA demand may exceed three, and sometimes be as great as five times the transformer nameplate rating, i. e., a machine normally rated 50 KVA may require as much as 250 KVA from the line. The problem of adequate power supply is particularly acute, if several welders operate from a common power circuit. It may be that any one machine will not cause excessive voltage drop, but poor welds will result if two or more machines are operated simultaneously.

Pointer-stop instruments are particularly useful for measuring the actual current drawn from the line, and for locating cause for otherwise unexplainable trouble. Pointer-stop voltmeters are available for measuring voltage drop.

Other Factors

For a given heat setting, the welding current varies with the materials being welding. As an example, a spot welding machine set to give 32,000 amp. with the electrodes together, may give 31,000 amp. when welding aluminum. However, if stainless steel of the same thickness as the aluminum is welded, with the same heat setting, primary voltage, etc., the current may only be 16,000 to 18,000 amp. This difference is caused by variation in impedance of the

RESISTANCE WELDING DATA.

Drg. No. 4124786 Name I-30 Meter Works WL

Type of Weld Projection Material CR-Steel 3/16" x 3/4" to CR-Steel 3/32" 13/16" (2 Projections)

Instructions Base and Yoke Ass. Surface Preparation Degrease

Top Elect. M3-(1015498-125) Change Every 7-Working Days Welds

Bottom Elect. M-3-(1015498-126) Change Every 7-Working Days Welds

Fixture Drg. 1C104-145 Location 1st X Filler Mat. & Flux " "

Date	Mach. No.	Bldg. & Dept.	Mach. Speed	Weldg. Pressure.	Trans. Tap	Heat Dial	Weldg. Pri. Amps.	Trans. Ratio	Weldg. Sec. Amps.	Short Cir. Amps.	Weld Time On	Weld Time Off	Weld Time Pul	Inspec. date weld or Panel.
3-1-40	10011	1st X Meter Dept.	Reeve's Drive Set-on 3	875 Lbs.	Ø Control	40	916	36:1	32976	33000	4	"	"	

Fig. 8—Card record of resistance welder data. Note the instructions given for installation of new electrodes. Used electrodes are sent to the maintenance department for re-machining.

secondary loop circuit, and this is a function of the thickness and specific resistance of the materials being welded.

It is, therefore, usually necessary to change the machine setting, in order to obtain the proper current for welding different materials.

It should be remembered that for spot welding applications, the actual current taken by the welding transformer is usually three to four times that indicated by the transformer KVA rating. Therefore, if a new machine is to be obtained for a given job, the user should specify the actual current required for welding the metals, the welding machine's throat dimensions, type of materials to be welded, and the number of welds to be made per minute. As an alternative, the complete problem should be submitted to the resistance welding manufacturer for recommendations.

Card Record Data

It has been found that a card record giving pertinent data for each welding operation makes it easy to control the variables which enter into the welding process, and obtain consistently good welds, transfer work from one machine to another, and minimize set-up time for repeat jobs. Each welding machine is provided with a pointer-stop ammeter, so that definite information on welding is always immediately available. After optimum conditions of welding current, "on" time, electrode pressure, etc., have been determined, the information is recorded on the card —and filed for future use.

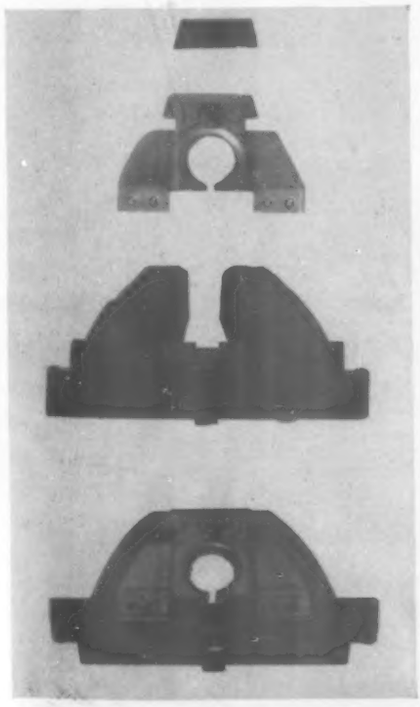


Fig. 9—Welded base and shunt-support assembly for magnet of watthour meter.

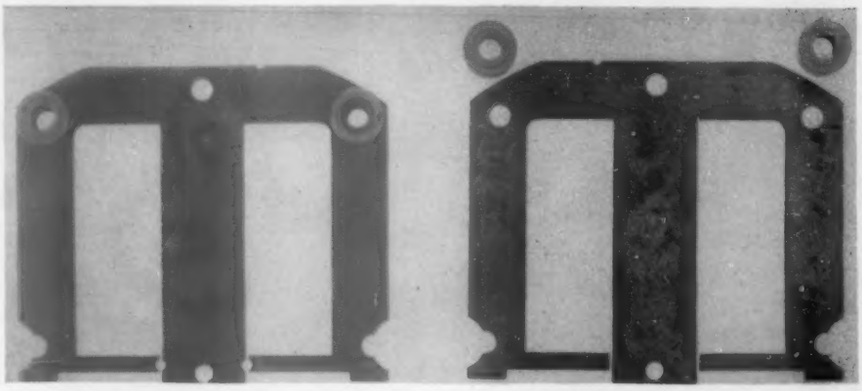


Fig. 10—Spacer and meter lamination assembly are projection welded in place. Note the small spacers.

By following this routine, we have placed our welding operations on an absolutely dependable basis. Of 350 different production jobs done at various times, ranging from set-ups once or twice a day to once a year, we know of practically no failures which can be attributed to the resistance welding equipment.

Fig. 6 shows a typical job which has been transferred from development to production by utilizing pointer-stop ammeters to determine the welding current.

A typical card record of welding machine data is shown in Fig. 8. With this record, a set-up man can go to any machine in the factory, install the proper fixture and electrodes, set the electrode pressure, the time and short circuit current, then turn the welder over to the operator for production welding of the material specified. During the first few welds, the actual welding current is checked, and the heat setting readjusted, if necessary.

A record of the short circuit current, in addition to that of the welding current, is very valuable, since a machine can be set up and small quantity jobs done without spoiling any of the pieces. The card record gives instructions on how often to install new electrodes. Used electrodes are not simply filed by the operator, but are returned to the maintenance department for re-machining to the original size and shape.

Conclusions

Resistance welding is recognized as one of our most important industrial tools. Although great progress has been made in controlling the quality of the work done by resistance welding machines, industry has been slow in recognizing the importance of maintaining the proper welding current. Hence, an unsatisfactory weld may result.

In order to know the optimum amperes needed for a job, and be able to set the welder accordingly, some means of measuring welding current is essential. Conventional ammeters are not generally suitable for measuring welding current since the time of current flow is usually much less than that necessary for a conventional ammeter to respond.

Ammeters, equipped with an adjustable pointer stop, provide a simple and practical means of measuring welding current of 1/20 sec. or more duration.

Experience has shown that by using pointer-stop ammeters for current measurements, it is practical to control the variables which enter into a resistance welding process. The results of such control are usually lower spoilage, reduction in cost, and improvement in the quality of the work.

» «

Are you passing your copy of THE WELDING ENGINEER *on to your friends so that they, too, may become better informed on welding?*

» «

Stainless Steel Tubing Fabricated

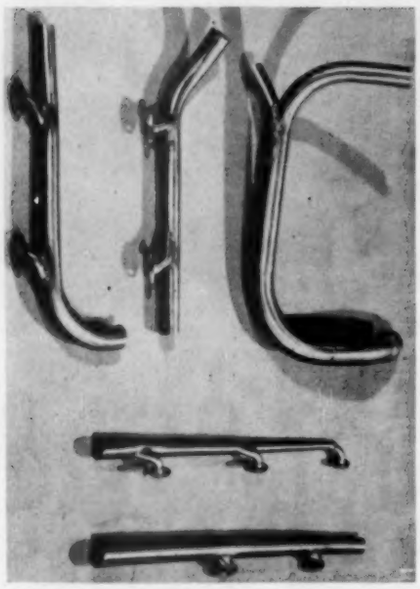


Fig. 1—Five typical parts which required several combinations of fabricating operations—welding, bending, tapering, flaring, expanding.

CHOICE OF ALLOY steels for the coolant circulating system of a recently developed liquid-cooled aircraft engine recognized the dual advantage of high strength and high resistance to corrosion in this application. A study of the preliminary designs indicated that it would be most economical to make the component parts of the system from welded stainless 18-8 tubing. This tube is made by a forming and welding process which starts with coiled 18-8 strip of the desired wall thickness and converts it to the tube form in a continuous mill operation.

Reference to Fig. 1, which illustrates five typical parts of the assembly, shows that the tubing undergoes a considerable variety of fabrication. Forming operations include bending, tapering, expanding and flaring. Also, welding is used to join tube bends and to join bolting flanges to outlets and inlets. Therefore it was necessary to examine the welding and mechanical working properties of the material, as well as the metallurgical effects of these fabricating operations. Consultation with a welded tube manufacturer resulted in several advantageous minor changes in the first design and the adoption of tubing specifications favorable to economical and safe construction.

This open-minded approach to questions of design and fabrication, taking advantage of the knowledge and experience of suppliers, is nearly always essential to satisfactory production when the material is outside the range of commonplace shapes of low carbon steel. Disappointments and delays can easily result from neglecting very simple rules, or from arbitrary choice of dimensions which may be more convenient than vital. On the other hand, intricate parts like those illustrated can be made to meet very close tolerance requirements by consulting the fabricator and ascertaining in advance what the maximum and minimum limits should be on the various items involved.

For example, in several of the parts shown it is necessary to join machined bolting flanges to formed pieces of tube. If these are finish machined to final size before welding it is extremely difficult to control the welding technique so that the whole part will fit into its place in the assembly without further machining. It is much easier to make the welding assembly with semi-finished flanges and do the machining thereafter.

Engineers of Alloy Manufacturing Co., Pittsburgh, Pa., were consulted on this fabrication problem, as a preliminary to preparing final specifications for the tube fabrication. A study of the plans disclosed several items which involved one bend in one plane interlocked with another bend in another plane without any tangent interval. As a forming and bending operation this is impossible unless done with a drop die. However, by forming the desired bends in different pieces of tube, and welding the bent tubes together, the desired shapes were produced with reasonable speed and cost, with the bends falling in the planes designated. (This type of welding operation can usually be avoided by further redesign when volume production warrants it.)

Each detail of the design was thus examined from the standpoint of the fabrication methods that were involved, and parts were produced that might otherwise have been classed as impractical with 18-8 material and a wall thickness of 0.032 in. Some of the small outlets were bent at a 5/8 in. radius, which is considerably below general practice.

It is apparent that the limitations on the fabrication of welded stainless steel tubing are no more severe than on other types of tubing, and that scrap losses are greatly minimized by taking advantage of this fact. Also, the designer will come out best by consulting freely with material sources and production departments, prepared to compromise wherever possible on details wherein satisfactory production may be facilitated.

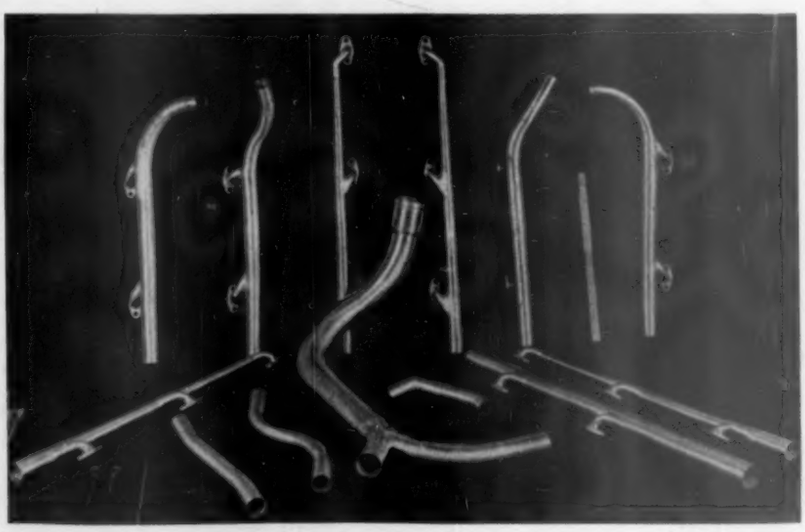


Fig. 2—Complicated structures, such as these components of an aircraft engine coolant system, may be formed by welding several pieces of tubing into a single unit.

Buses and Trucks "Kept Rolling"

Official photo, U. S. Army Signal Corps

The new M-4 tanks have welded and cast hulls.

Welding, brazing, metal spray and chrome plating are used extensively in England to rebuild worn bus and truck parts. These applications conserve vital materials besides helping to reduce repair costs.

GREAT BRITAIN has had nearly three years of war, but most of her trucks and buses are still running. Despite far less ample supplies of spare parts than operators had at their command in this country when the United States entered the war, and despite the fact that many vehicles and stores of spare parts were destroyed in air raids, Britain has kept her highway transport facilities in operation.

In the belief that some knowledge of how this has been accomplished would be of real value to truck and bus operators in the United States, the Transportation and Maintenance Activity Section of the Society of Automotive Engineers made a study of maintenance methods being used in England.

This study was made to further the preventive maintenance program of the Office of Defense Transportation and has been approved and distributed by the Vehicle Maintenance Section of the ODT's Division of Motor Transport.

The SAE found that, as might be expected, there have been developed many methods for reclaiming and rebuilding available used parts in order to make the most of existing equipment. The salient features of preventive maintenance as used in England follow:

Engine

Pistons. Pistons are removed at predetermined periods for inspection. Worn ring grooves are machined to receive oversize width piston rings. Worn or broken ring lands, including top land in aluminum pistons, are filled by aluminum welding and remachined. Skirts are expanded by any one of several American processes. Tin plating has been used to prevent seizure of cast iron pistons. Badly worn piston pin holes have been bored out and fitted with phosphor bronze bushings and in some cases, pins have been oversized by chromium plating.

Crankshafts. Both chromium plating and metal spraying have been used. There is one complaint that journals are not reliable to less than .002 in. tolerance, which presents difficulties in line boring. This would indicate that British machining is not up to American standards. Some operators use standard undersizes before building up the crankshaft while others keep shaft to standard to eliminate the necessity for several undersize bearings.

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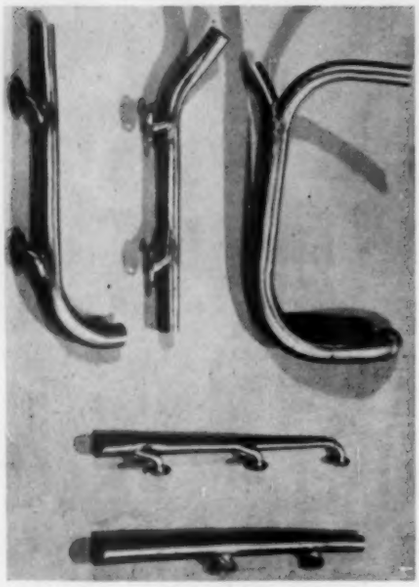

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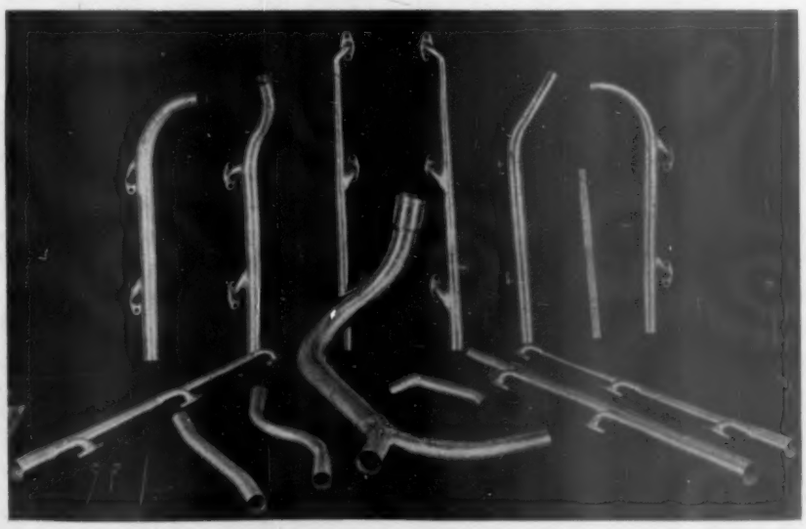

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on tappets. Chrome plating has also been found useful on rocker arm shafts.

Clutches. Clutch faces on the flywheel have been repaired by a hard-facing deposition. There is a record of one operator straightening buckled clutch plates by heating them with a gas ring and subjecting them to pressure between two cast iron plates. Chromium plating has been used successfully on clutch discs. Arc welding has proved successful on toggle levers. Nickel and chromium plating, as well as deposition by arc welding, have been successful on a number of transmission shafts and other parts such as shifter forks.

Differential

Metal spraying has been used to rebuild differential yokes at the surface that holds the differential bearings. This is difficult to machine so that the ring gear remains square with the carrier, but it has been done. Some firms have been successful in building these surfaces up with arc welding. Sleeves on the inside of differential cases have been built up by oxy-acetylene welding and then bored out. Spring pads have been built up by arc welding.

Running Gear

Springs. Broken main leaves have been converted into intermediate leaves where breakage has occurred adjacent to the spring eye. Shackle pins have been chrome plated. In addition to building them up to standard size, this has doubled the life of the pins by providing increased resistance to wear and prevention to rusting. Some pins have been machined down and fitted with undersized bushings.

Wheels. Where ball or roller bearings have become loose in front wheel hubs, brazing has been used to build up the internal areas so they can be rebored. Some hubs have been chrome or nickel plated.

Front axle. Chrome plating has been used to build up king pins. One operator has machined his king pins down and fitted undersize bushings. Another grinds king pins down to a standard undersize and then builds them up to the regular standard by deposition of the weld metal after subsequent use.

Axle shafts. Axle shaft splines are built up and filled in with welding. The splines are then milled into the shaft in such a position that the driving face is of parent metal. Splines have also been built up with chromium plating. Keyways have been reclaimed by brazing.

Cylinder Heads, Cylinder Blocks and Crankcases. Cylinder heads[1] have been salvaged and leaks stopped by welding, metal spraying and cold welding. Welding and cold welding have also been successful on cylinder blocks. Valve seats have been built up by welding hard-facing onto the worn valve seat. Both cast iron and aluminum crankcases have been successfully welded. Minor cracking of blocks and heads as a result of leaking head gaskets has been cured with bronze welding.

[1] See "Repairing Cylinder Heads," THE WELDING ENGINEER, February, 1942, for most up-to-date information on this hard-to-do job.

New AWS Codes

IMPORTANT new standards for mechanical testing of welds, definitions of welding terms and a specification for iron and steel gas-welding rods have just been published. Copies of all three may be obtained from the American Welding Society, 33 W. 39th St., New York City.

The first two of the above mentioned standards are copyrighted by AWS and are published as booklets, available at 40 cents per single copy. "Tentative Specifications for Iron and Steel Gas-Welding Rods," a 6-page bulletin issued jointly by the American Welding Society and the American Society for Testing Materials, is priced at 25 cents per single copy. All three of the new standards are described briefly below:

Standard Methods for Mechanical Testing of Welds describes in detail the principal mechanical tests applied to welds — density, soundness, tensile strength, shearing strength, ductility, etc. Many sketches supplement the descriptions of test procedures. Some of the tests apply to the weld metal alone; others apply to butt-welded joints and to fillet-welded joints. A section on etching reagents and etching procedures is also included.

Definitions of Welding Terms and Master Chart of Welding Processes is a very useful and handy reference for the standard definitions of welding terms adopted by AWS. Instead of being arranged in the conventional alphabetical order, the terms are grouped under such headings and subheadings as "Types of Joints and Welds," "Arc Welding," "Gas Welding," etc. Thus closely related terms appear together, and their relationships may be more readily comprehended. An alphabetical index is also included, and a "Master Chart" showing the various subdivisions of the principal welding processes appears as a frontispiece. Illustrations to the number of 51 assist in clarifying the definitions so that their meanings may be quickly grasped.

Tentative Specifications for Iron and Steel Gas-Welding Rods (Serial Designation: A 251-42 T) covers rods for the welding of carbon and low-alloy steels of weldable quality. These specifications were prepared jointly by the American Welding Society and the American Society for Testing Materials and issued as a Tentative Standard subject to annual revision. They include sizes and length, chemical composition, tension tests, face- and root-bend tests of welded joints, permissible variations in dimensions, workmanship and finish, packing, marking, and manufacturer's guarantee.

Welding School Code

Just as THE WELDING ENGINEER goes to press, AWS announces publication of the *Proposed Code of Minimum Requirements for Instruction of Welding Operators*, Part A —Arc Welding of Steel. This new standard is extremely important because, under the recent Limitation Order L-146, only those schools complying with the code will be given directives for welding electrodes and rods.

The code begins with definitions of basic terms, followed by provisions regarding the objectives of the course, selection of students, trial period of instruction and issuance of student record cards.

Section II covers the equipment and facilities of the school—its welding booths, arc-welding machines, electrodes and materials for welding, testing apparatus, etc., as well as the duties of the instructor, length of course and hours of instruction. It is stated that there shall not be more than 15 students per instructor for any shop class and that each student shall be required to devote a minimum of 160 hr to actual welding (not more than 6 hr in any one day) and a minimum of 20 hr to instruction in welding theory.

In Section III the qualifications of instructors are given. An instructor must possess a minimum of four years' total experience as a welding operator or welding supervisor, at least two years of which shall have been spent as a metal arc-welding operator.

Fig. 1—When blowing dust from a welder, use low-pressure air to avoid driving abrasive dust into insulation.

Welding Machine Maintenance

By R. F. WYER

Welding Engineer,
General Electric Co.

Conservation is in order! Proper equipment maintenance will conserve needed war materials, reduce operating costs and result in increased production. Both A-C and D-C welders require maintenance.

WHILE arc welding sets today represent the highest in simplicity and reliability, they require periodic attention from a maintenance standpoint if they are to be kept in the best operating condition. With the accent on production in shipyards, ordnance plants, and welding shops of all types, failure of even a few sets is sometimes costly. Systematized maintenance will pay dividends in terms of better welder performance and longer life.

Welder Selection

The right welding set must be selected for the job, because a maintenance program will be discouragingly difficult if misfit equipment is being used.

To insure proper choice of the rating of a single-operator set, the maximum current, load voltage, and duty factor (ratio of arc time to total time) must be taken into account. Except in the smallest sizes, most sets are rated on a one-hour load. Their rating is the current which they will deliver for one hour without interruption, without exceeding a prescribed temperature rise.

Since this method of rating, chosen as a simple standard for comparison, does not take into account actual operating conditions, it is not always economically sound to choose the size next larger than the maximum operating current contemplated. However, for this same reason, duty factor should be taken into account when new equipment is being considered to make certain that the set is big enough for the job.

Installation

Proper installation can do much to keep the welding equipment at work and troubles to a minimum. In connecting a welding set, care should be taken to provide adequate branch circuit conductors and fuse clips large enough to accommodate the necessary fuses. It should be observed that motor-generator type welding equipments have full-voltage motor starters almost without exception, so that due consideration must be given to the starting current of the motors.

Care should be taken to ground the frames of all welding equipment in order to avoid shock or annoying tickles when a grounded person touches the frame of the equipment. Under some conditions, even with equipment in perfect operating condition, it is possible to receive a harmless but irritating sensation of shock due to the passage of infinitesimal capacity or leakage currents. In addition to protecting against this annoyance, adequate grounding of machine frames is also a desirable safety precaution against harm resulting from insulation failure in equipment or leads, or improper connections.

Regardless of the type of safety ground connection which is installed, adequate low resistance work leads should always be used, and care should be taken to secure good connection between the work lead and the work. If this is not done, it is

Fig. 2 — Hand-operated grease guns should always be used on pressure-relief lubricated bearings. Grease should be added slowly to permit excess to vent from relief pipe or plug.

possible under some circumstances to overheat the safety ground connection by passage of welding current through it.

In locating welding equipment, ventilation is a very important consideration. The life of electrical insulation is seriously shortened by overheating, and overheating is bound to result where insufficient ventilation is provided. Where large numbers of welding equipments are to be located in small enclosures, considerable study should be given to the problem of supplying clean, cool ventilating air. Where small houses or temporary sheds are located in hot sunshine, the heat absorbed from the sun added to the heat dissipated by the welding equipments may raise the ambient temperature above 100 F and cause severe overheating. In such cases, large louvers or other ventilating openings should be provided in the building, not only at the bottom but near the roof, to give air circulation and keep the ambient temperature below 100 F. In some instances, it is desirable to provide exhaust fans to assist in removing heated air from the upper part of such enclosures.

Inspection and Servicing

The competent maintenance man will have a record of all welders under his care. One of the most useful and easy-to-handle references is a card file. All repair work, with its cost, can be entered on the record, and any welder requiring excessive attention or expense can be investigated and causes determined and corrected. A suggested type of record card is pictured in Fig. 3. This card provides space for general information regarding the welder as well as a service record.

Inspection records will also serve as a guide to tell when welders should be replaced because of the high maintenance cost. Misapplications, abuses, and the like will also be disclosed.

Periodic Inspection

Systematic and periodic inspection of motors and generators is necessary to insure best operation. While some welders are installed where conditions are ideal—where dust, dirt, and moisture are not present to an appreciable degree — most machines are located where some sort of dirt accumulates on the windings. This lowers insulation resistance and cuts down creepage distances.

Steel-mill dusts are usually highly conductive, if not abrasive, and lessen creepage distances. Other dusts are highly abrasive and actually cut the insulation in being carried through by the ventilating air. Fine cast-iron dust quickly penetrates most insulating materials.

Hence the desirability of inspecting motors periodically. If conditions

Amp | Speed | Make | Connection Diagram | Application | Shop or Mill No. | Card No.

Type | Motor Voltage | Time or Duty Cycle | F.L. Amp. | Phase | Cycles

Serial No. | Publication No

Model No.

BRUSHES

No. | Cat. No. | Size | Material | Grade

COILS (Cat. or Spec. No.) Motor: Stator, Main, Comm, Comp. | Generator: Field, Main, Comm, Comp., Armature

Coils | Bars | No. per set

BEARINGS

Front End, Cat. No. | Motor End, Cat. No.

Mfr's Order No. | Our Order No. | Date of Order | Cost

User: Location:

SERVICE RECORD

Date	Shop	Year	Service (Tacking, etc.)	Duty Factor	Tested Load: Volts	Amps

REPAIRS

Date	Condition	Due to	Repaired by	Cost

MAINTENANCE

Greased: Date	By	Inspected: Date	By	Cleaned: Date	By

Fig. 3—A record card similar to this will be found handy for reporting welder operation.

are extremely severe, weekly inspection and partial cleaning are desirable. Most motors require a complete overhauling and thorough cleaning about once a year.

Once a Week

For the weekly cleaning, the motor and generator should be blown out with dry compressed air (about 25 to 30 psi in pressure). Where conducting and abrasive dusts are present, even lower pressure may be necessary, or suction preferred, as damage can easily be caused by blowing the dust and metal chips into the insulation. On most motors the windings are fairly accessible, however, and the air can be properly directed to prevent such damage.

Once a Year

About once a year, welders should be overhauled. First, the heavy dirt and grease should be removed with a heavy, stiff brush, wooden or fiber scrapers, and cloths. Rifle-cleaning bristle brushes can be used in air ducts. Dry dust and dirt can be blown off, using dry compressed air at moderate pressure. Care must be taken to direct the air so that the dust will not cause damage and will not be pocketed in the various corners. Grease, oil, and sticky dirt are easily removed by applying cleaning liquids such as carbon tetrachloride.

If the welder can be spared from service long enough, the insulation of the motor should be dried out by heating to from 90 to 100 C. While the motor is still warm, a high-grade insulating varnish should be applied.

The varnish may be sprayed or brushed on. After applying the varnish, the best results are obtained by baking for 6 to 7 hr at about 100 C. If the machine must be put back into service quickly, or if facilities are not available for baking, fairly good results will be obtained by applying one of the varnishes which dry in a few hours at ordinary room temperatures.

Lubrication

Manufacturers' instructions regarding lubrication of bearings should be carefully noted. These instructions should be kept near the welder so that they are readily accessible. Usually grease-packed bearings have sufficient lubricant when shipped from the factory to last about a year under normal conditions of cleanliness and temperature. When sets are operated in unusually dirty atmospheres, run continuously 24 hr per day, or exposed to extremes of temperature, it would be well to shorten the bearing inspection and lubrica-

tion interval down to six months, or less if experience warrants. An occasional check of bearing temperature by feeling with the hand may disclose undue heating before damage is actually done. Once a lubricating routine has been established, it should be carried out — and by reliable men who will follow instructions.

It is pretty generally established that outside of gross neglect for long periods of time, the major causes of bearing troubles are overgreasing and dirt. Overgreasing results in excessive heating of the bearing, frequently with churning and breaking down of the grease with consequent loss of its protective qualities.

Dirt occasionally gets into a bearing through the use of grease that is carried around or stored in uncovered containers. Quite as frequently it gets in through carelessness in protecting parts while bearings are disassembled or opened for inspection. The prevention is obvious but often overlooked:

Every part of a bearing assembly, including retainer plates, gaskets, and screws, should be placed in a clean box immediately on removal, and if dropped or otherwise soiled, should not be replaced without a thorough cleaning in a suitable solvent.

None but clean hands, tools, and rags should ever be allowed to touch a bearing.

Grease must be clean. If there is the slightest doubt of its purity, it should be thrown away. Grease is cheap compared with bearings and lost man-hours. *Use only the best grade of grease!*

Brushes

Brush inspection is important. The first essential requirement for the satisfactory operation of brushes is the free movement of the brushes in their holders. Uniform brush pressure also is necessary to assure equal current distribution. Adjustment of brush holders should be set so that the face of the holder is approximately ⅛ in. from the commutator; any distance greater than ⅛ in. may cause brushes to wedge, resulting in chattering and excessive sparking.

It is essential that the correct grade of brush for a specific application be used. Recommendation as to the correct grade of brush should be obtained from the manufacturer of the welder only.

Broken brushes imply two possibilities: incorrect brush grade, or mechanical defects (such as unbalanced, rough, or eccentric commutator). To eliminate brush breakage, both factors should be corrected.

Check the brushes to make sure that they will not wear down too far before the next inspection. Keep extra sets of brushes available so that replacement can be made when needed. It is false economy to use brushes down to the absolute minimum length before replacement. Cases have been known where brushes have worn down until the metal, where the pigtail connects to the brush, was touching the commutator. This, of course, was causing damage to the commutator.

Make sure that each brush surface, in contact with the commutator, has the polished finish that indicates good contact, and that the polish covers all of the surface of the brush. When replacing a brush be sure to put it in the same brush holder and in its original position. It has been found helpful to scratch a mark on one side of the brush when removing it, so that it will be replaced properly.

When installing new brushes, fit them carefully to the commutator. Sand only until the curve of the brushes is the same as that of the commutator. Be sure that the brush shunts (pigtails) are fastened securely so that current will not overheat the brushes and brush holders.

Check the springs that hold the brushes against the commutator. Improper spring pressure may lead to commutator wear and excessive sparking. Excessive heating may have annealed the springs, in which case they should be replaced and the cause of heating corrected.

Commutators

Inspect the commutator for color and condition. It should be clean, smooth, and glossy, with a color varying from straw to chocolate brown where the brushes ride on it. A bluish or reddish color indicates overheating of the commutator. Roughness of the commutator should be removed by sandpapering or stoning. Never use emery cloth or an emery stone. Use a "fine" stone or number 00 sandpaper unless the commutator is in bad condition, when the job may be started with a "coarse" stone and finished with "fine."

For this operation, press the stone or sandpaper against the commutator with moderate pressure with the motor running, and move it back and forth across the commutator surface. Use care not to come in contact with live parts. Be sure to keep the dust out of the machine.

If the commutator is very rough, as evidenced by pronounced up and down vibration of the brushes, the armature should be taken down and the commutator turned down in a lathe. When this is done, it is usually necessary also to cut back the insulation between the commutator bars slightly. If the commutator is found to be dirty when the generator is inspected, it should be wiped clean with a piece of canvas or other cloth that is free from lint.

Never put oil on the commutator. Proper selection of brushes gives the commutator all the lubrication required to prevent excessive wear and to build up a good smooth operating glazed surface on the copper. The addition of oil results in the development of a high resistance film which may cause undue heating and rough brush action.

Transformers

The arc welding transformers of A-C welders require a minimum of maintenance, but this fact should not be allowed to result in neglect. On fan-cooled units, fans should be cleaned and lubricated about once a year. Windings should be blown out at least twice a year in very clean locations and more often in dusty places. At the time of this periodic attention, all connections and coil supports should be checked for tightness. Manual current adjusting mechanisms should be lubricated often enough to prevent stiff operation of the handwheel or crank, making sure that a fairly high melting-point grease is uniformly distributed over the full length of screws and guides. On motor-operated controls, lubrication at more frequent intervals may be required, as evidenced by slowing down of the motor or noise from the gearing. This point should be checked at least three times a year, and more often if experience justifies it.

Abuses

While most welding equipment is designed to stand up under unusually adverse operating conditions, some not infrequent circumstances will cause serious impairment, if not complete interruptions, of service.

One bad practice, for example, is that of leaving weather-protecting tarpaulins thrown over machines in operation, in such a way as to interfere with the free passage of ventilating air into and out of the equipment. Cases are known where welders have been equipped with canvas flaps permanently installed on inlet and exhaust air openings, resulting in severe overheating and very short equipment life.

(*Continued on page 60*)

The Technical Slant

Employ your time improving yourself by other men's documents; so shall you come easily by what others have labored hard for.—*Socrates*

Welding

WELDING—ITS QUESTIONS AND ANSWERS. *By T. B. Jefferson. Published by The Welding Engineer Publishing Co., Chicago, 1942. Cloth, 5 x 8 in., 176 pages. Price $1.50.*

Welding—Its Questions and Answers, as the name implies, is a question and answer type book. In this volume the author has answered some 500 practical questions which frequently confront the engineer, supervisor, weldor and trainee. While the answers are concise they are usually thorough and cover all details relating to the problem at hand.

One fault which might be found with the volume is that the author has tried to cover too much ground in too few pages. For example in the chapter on automatic welding discussion is devoted primarily to the submerged melt (Unionmelt) process. Similarly the chapter on weldable materials is devoted wholly to ferrous and non-ferrous alloys. The latter chapter, incidentally, presents a very complete discussion on magnesium welding.

The book which is in ten chapters and well illustrated opens with a chapter on welding processes and terminology and in addition to the two previously mentioned includes chapters on arc, gas, resistance and thermit welding, cutting processes, flame treating, and testing and inspection.

The information presented in the final chapter, testing and inspection, is quite complete and should prove of value to all engaged in welding. Another feature of the book is a fairly complete index.

Welding—Its Questions and Answers is indeed a compact volume on welding. It is ideally suited as a text and will prove of equal value to one desiring to study welding at home or during leisure hours.

» «

WELDING AND METAL CUTTING. *By E. Molloy. Published by Chemical Publishing Co., Brooklyn, 1942. Cloth, 5½x8½ in., 110 pages. Price $2.50.*

This is another of those welding books which has been written for the American public yet has been based on English welding terms and experiences. Since the information is based on British practice some of it will prove quite confusing to the readers in this country and consequently will be of little value. This is particularly true in the second chapter which discusses oxy-acetylene welding and the equipment used.

The volume opens with four pages devoted to a general survey of the welding processes followed by chapters discussing oxy-acetylene, arc, resistance and Thermit welding. There is a chapter on the testing of arc welding and two chapters on flame-cutting, manual and machine, respectively, to complete the book. Included in these latter chapters is data on the cutting of stainless steel.

It is unfortunate that American publishers do not publish books for Americans because while this is an excellent book from the British point of view it will not give the American engineer a "practical survey of present-day methods and equipment"—the intent of the author.

» «

Electrical

DEFINITIONS OF ELECTRICAL TERMS. *Published by American Institute of Electrical Engineers, New York, 1942. Fabricoid, 8 x 11 in., 309 pages. Price $1.00.*

This volume of electrical definitions as an American Standard should mark an epoch in the literature of the electrical art in America, as it is the first time the definitions of the important terms common to all branches of the art as well as those specifically related to each of the various branches have been assembled and printed under one cover.

This glossary is the result of more than twelve years' work of a sectional committee of 46 members having 18 subcommittees drawn from available specialists. More than 300 individuals have given material assistance and many others have assisted in specific instances. The 34 organizations represented on this sectional committee include the national engineering, scientific and professional societies, trade associations, government departments and miscellaneous groups.

The primary aim in the formulation of the definitions has been to express for each term the meaning which is generally associated with it in electrical engineering in America. The definitions have been generalized wherever practicable to avoid precluding the various specific interpretations which may be attached to a term in particular applications. It has been recognized that brief, simplified phrasing usually presents the clearer word picture. Amplifying notes accompany certain definitions when the added information is particularly helpful, but those notes are not a legitimate part of the standard phrasing. Words used in the definitions have been employed in the accepted meaning as given in the recognized dictionaries, unless they have been defined specifically in this glossary. Specialized definitions for common words have been discouraged.

This new American Standard has unified and perfected the existing groups of definitions and has rounded out those groups and added many new groups. Its coverage is more than three times that of this field in any other language. It should prove of great value to the general public as well as to scientists and engineers for it is a function of the recognized dictionaries into specialized fields not hitherto covered. The definitions of the various electrical fields have been grouped and the volume is completely cross indexed.

» «

Furnaces

INDUSTRIAL FURNACES. VOLUME II, SECOND EDITION. *By W. Trinks. Published by John Wiley & Sons, Inc., New York, 1942. Cloth, 6 x 9 in., 351 pages. Price $5.00.*

The second edition of Volume II is, in general plan and scope, similar to the first edition. In the new edition the material presented in Chapters VI and VII have been combined and those parts of Chapter VI which were practically a repetition of Chapter I have been omitted.

Industrial Furnaces opens with a discussion of fuels and heat sources. This is followed by chapters on: combustion devices and heating elements; control of furnaces temperatures; control of furnace atmospheres; labor savings appliances and critical comparison of fuels and of furnace types. Because of the wide field covered, the author has supplemented his own experience by that of others, as presented in publications and communications in which individuals and firms recorded their experiences.

Volume II is a continuation of Volume I, but is complete in itself. While the first volume contains a great deal of theory and appeals mainly to the designer of furnaces, the second is devoted primarily to practice and will be found to be a valuable aid to co-ordinators of existing furnace designs.

» «

War Metallurgy Committee

The **War Metallurgy Committee** is a recently organized agency of the National Academy of Sciences and the National Research Council, charged with the conduct of metallurgical research for the War Production Board and the National Defense Research Committee of the Office of Scientific Research and Development. The Committee operates through three major sections; the first, formulating and placing research projects; the second, supervising the operation of these researches; and the third section correlating the Committee's work with war metallurgical research of other government agencies.

The Metals and Minerals Advisory Committee of the Academy serves both the War Production Board and the War Metallurgy Committee on problems involving production, substitution and conservation of strategic materials. **Clyde Williams,** Director of Battelle Institute, Columbus, Ohio, is chairman of both Committees. **Louis Jordan,** National Academy of Sciences, Washington, is executive secretary.

Welding Protection Equipment made to be Comfortable, Safe...

—by American

No. TX-100 Welding Gloves. New. Gun cut pattern. One-piece back, no exposed seams. Made of best cowhide. Double-stitched. Re-enforced. Durable. Comfortable.

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No. 440-4-A Helmet. One-piece, with 10" vertical face. Made of highest quality fibre. Fitted with AO NOVIWELD plates that screen out dangerous rays and prevent "lost time eyes."

In the complete AO line, there is just the right type of welding protection equipment for every need—welding goggles, helmets, handshields, welding gloves and aprons. And every American product can be counted on to provide workers with utmost safety, comfort and durability.

American Duraweld Goggles are light, well ventilated, comfortable to wear. They are fitted with NOVIWELD lenses, manufactured *only* by American, which are scientifically compounded to actually screen out more than *99 per cent* of all dangerous rays, yet pass working light through so freely that welders can clearly see every detail of their work.

Ask your AO representative to show you the Duraweld Goggles and the entire American Optical welding line.

American Optical Company

SOUTHBRIDGE, MASSACHUSETTS, U. S. A.

GET EYE ACCIDENTS OUT OF YOUR SYSTEM—WITH AMERICAN OPTICAL GOGGLES

1568

Brief Sketches of Welding Jobs

Conserving Scarce Alloys

Steels containing the strategic elements of nickel, chromium, tungsten, cobalt and vanadium are now on the War Production Board's restricted list. In their stead, WPB suggests that carbon steel, intermediate manganese steel, carbon-molybdenum and manganese-molybdenum steel and silico-manganese steel be used wherever possible.

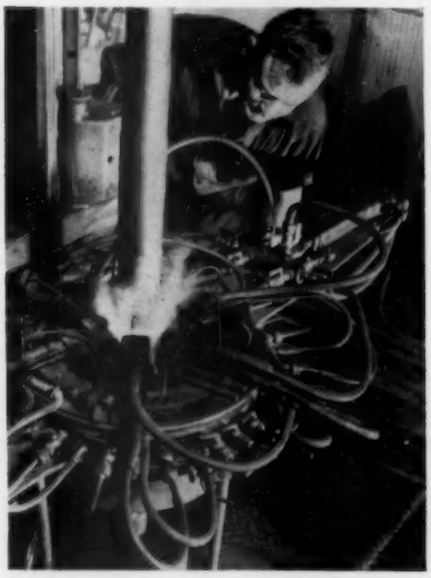


Photo by The Linde Air Products Co.

This shaft-hardening machine was made from an up-ended lathe. The shaft is rotated during hardening, and the flames progress upwards, followed by a ring quench.

By means of oxy-acetylene flame-hardening, these suggested National Emergency steels can be made satisfactory alternates for the standard alloy steels customarily employed for such parts as dies, shear blades, pump liners and piston rods. The equipment is light and easy to operate, consisting of one or more flame-hardening heads, an oil or water quench and a means of propelling the head and quench at a set speed or of turning the part being hardened (see illustration above).

Flame-hardening imparts a maximum hardness to the surface of quench-hardenable steels without affecting the toughness and ductility of the core metal. Therefore, parts can be furnace-treated if necessary, for special core properties and then flame-hardened to produce the desired surface condition.

The hardening effect can be restricted to those surfaces where it is actually needed, and the degree and depth of hardness can be controlled accurately by this method.

» «

Old Knives Made New

Hard-facing has become a vital necessity in the drive to speed American war production. Metals worn away during manufacturing processes are usually non-reclaimable and lost to the war effort. Badly worn parts also lose efficiency, slow down plant output and increase operating costs.

What may be done with hard-facing is shown by the five pug knives below.

At the extreme left is a new high alloy steel pug knife which weighs 24 lb. The next two knives show the results of only three months' service. Note over half of the blade material has been worn away—worn metal which, like chips from a cutting operation, cannot be salvaged. It is simply wasted.

These worn knives resulted in a varying but progressive loss of efficiency over a three month operating period.

The two knives at the right are made of the same material—high alloy steel—but the blades were protected by a coating of chromium boride alloy hard-facing, 1½ lb being deposited on each blade. These knives had been in constant service for over a year when this picture was taken, and they are still operating efficiently.

The knives so badly worn can be reclaimed. This is done by cutting the worn stub and welding in its place a new low carbon steel blade protected by hard-facing. As a result 24 lb high alloy steel is replaced by approximately 5 lb of low carbon steel and 1½ lb hard-facing. Multiply this saving by the increased life of the knife, and the benefits of the hard-facing process will become readily apparent.

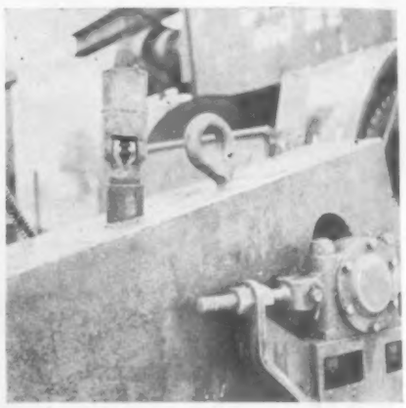
A new pug mill knife ready for service (extreme left); the next two, unprotected, knives show the wear of three months' service, while the last two, hard-faced, knives show little wear after a year of action.

Photo from Wall-Colmonoy Corp.

Oil Cup and Guard

By C. C. LYNDE

Frequent damage to the usual glass-bodied oil cup used to lubricate a main drive chain on a drilling unit led to the design of the sturdy unit below:



Mounted on a drilling unit where it must withstand severe service, this welded oil cup has satisfactorily replaced the usual, glass-bodied type.

Using a 3 x 2 in. reducing swedge as body, the company weldor set in a tight base just above the curved section of the fitting, the disk being tapped in its center for a ¼ in. petcock. The sides of the tapered section were cut out on either side with the torch, making the valve handle accessible and permitting visual check of the rate of oil feed.

A 3 in. pipe plug, with ears welded on for handy manipulation, served as top of the oil container. The unit, screwed into a 2 in. pipe collar welded into the top of the chain case, was sturdy enough to withstand a severe blow and provided capacity for sufficient oil for a day's run.

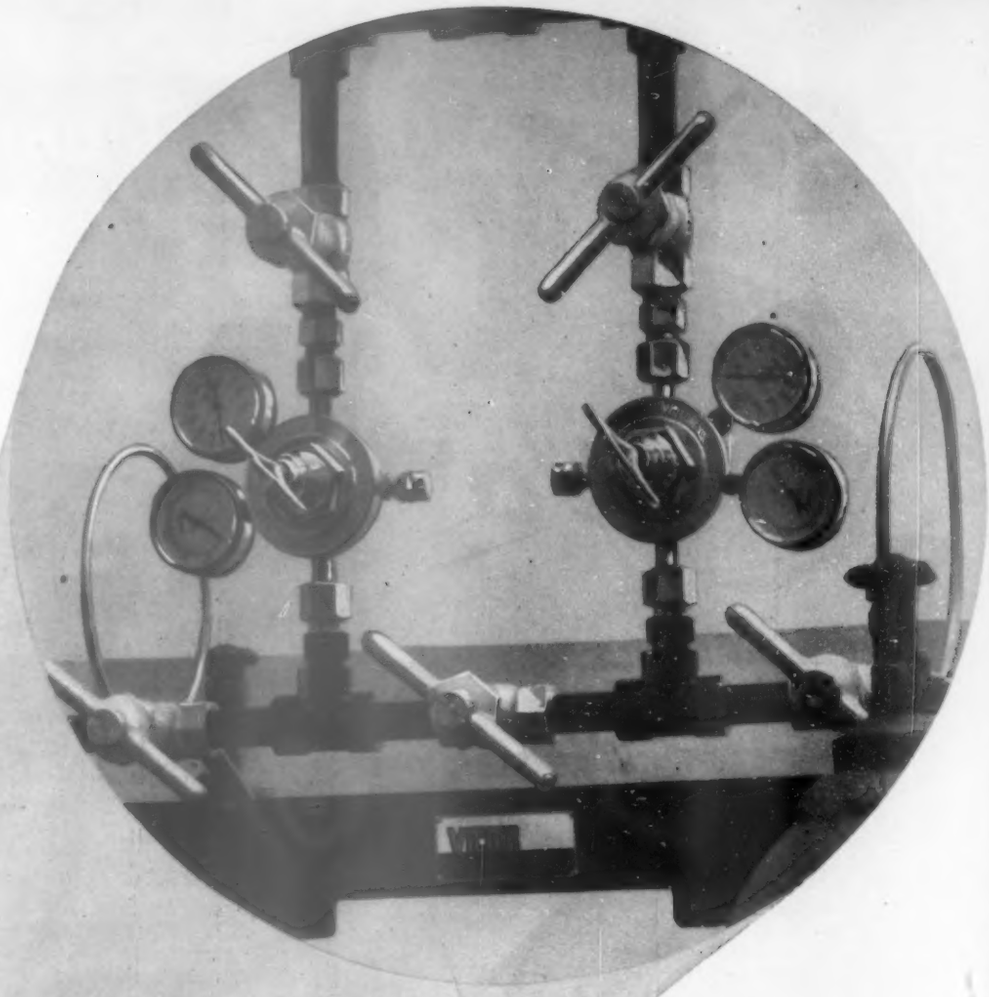
» «

Improving Copper With Silver

Silver is especially useful in copper which is to be soldered, as the heat applied does not result in undue softening. A welding rod containing about 1% silver and a trace of deoxidizer, the remainder being copper, is said to be favored by coppersmiths. Some commercial copper alloys designed for high conductivity contain about 1% of silver. Silver, of course, is often an important element of brazing alloys in which copper, even up to 85%, is one ingredient, but in these alloys 10% or more of silver is commonly used. High fluidity and good penetration into small clearances, as well as low melting points, are among the advantages gained by the use of silver in such alloys . . . *From a recent report of the American Silver Producers' Research Project.*

VICTOR

FOR PERFECT CONTROL OF CYLINDER GASES



EMPTY CYLINDERS WASTE PRECIOUS TIME

MANIFOLDS help to send empty cylinders to refill plants; they reduce gas wastefulness and save precious operator hours.

VICTOR Cylinder Manifolds (wall or floor types) are sturdily constructed and the center control section so designed that the two cylinder banks may be discharged simultaneously through either one or both regulators. This arrangement takes care of the peak-hour loads and, in case of regulator seat failure, permits that regulator to be cut out of the manifold without service interruption.

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★

New Product Developments

Ransome's new heavy duty positioner will handle a maximum load of 22½ tons.

Heavy Duty Positioner

★ A new **heavy duty welding positioner** has been added to the line manufactured by the Industrial Division of **Ransome Concrete Machinery Co.,** Dunellen, N. J. This machine will handle a maximum load of 22½ tons, with a center of gravity up to 12 in. above the table top. Work may be tilted to any position through a range of 45 deg from horizontal in one direction to a vertical position in the other. The positioner will also rotate any load up to capacity with an eccentricity up to 12 in. from center of the table top.

The table, controlled through a remote push-button control station, rotates a full 360 deg in either direction at a speed of ⅛ rpm. Separate driving motors for tilting and rotating permit these two movements to be accomplished simultaneously. The two tilting gear segments provide a means for tilting the load uniformly even when an unbalanced load is being handled.

The 84 in. square steel table top is machined, reinforced by ribs on the under side and provided with four radial and four longitudinal T-slots for attaching work to table surface. Frame is of all-welded construction. V-belt drive between motors and gear reduction units is used, and table top spindle shaft turns in two Timken bearings for permanent alignment of mechanism.

» «

New Welder Trailer

★ **The Harnischfeger Corp.,** Milwaukee, has announced the immediate substitution of an all-steel wheel portable mounting on its P&H gas engine-driven **welders for the rubber-tired trailer.** The new trailer is of the two-wheel type, equipped with an axle and heavy duty springs, and suitable for field work and highway towing. The wheels have a 24-in. diam and 4-in. rim face, and are designed to permit quick changeover to a pressed steel wheel, with pneumatic tire when available later. The towing bar and trailer rest have not been changed.

To compensate for the harder riding of steel rimmed wheels, the new unit is built for heavy duty in every way, with a 9-leaf spring as well as extra heavy axle.

» «

Even when provided with the heaviest lenses produced by its manufacturer, this new goggle—identified as Model No. 421—weighs but 3 oz.

Industrial Goggles

★ Light-weight, "non-fogging" **goggles for industrial workers** are announced by the **Sellstrom Mfg. Co.,** 615 N. Aberdeen St., Chicago. A series of vents through which trapped air may escape is placed all around the back of the lens. These vents, operating in connection with fine metal screens placed at either side of the goggle, provide a continuous flow of air into the eye cups. According to manufacturer, this system of air intake and exhaust eliminates practically all chances of lens fogging.

Goggle frame is of moulded Durez plastic. Eye cups are of the shallow type, designed with rounded edges for snug fitting of the face. Nose bridge is of rubber covered ball chain style with adjustable chain anchor capable of being fitted to 1/1,000 in.

» «

High Frequency Welder

★ The **"Missing Link,"** automatic arc "Hy-Cycle" unit, is a high frequency attachment for arc welders said to produce over a million impulses per sec (120 impulses per sec result from ordinary 60-cycle current). At this high frequency, the arc will start automatically without the electrode touching the work. Hence freezing of electrodes is eliminated, and higher currents for starting are not necessary. Thus excessive currents for thin or easily burned material may be better avoided and the new ⅛ in. and ¼ in. electrodes used satisfactorily.

The "Missing Link" adds no amperage to the welder. It may be attached to any arc welder, either A-C or D-C, but is used primarily with A-C welders. It is offered in two models: No. 1 (illustrated) for use on welders with capacity 0 to 300 amp and No. 2 for welders with capacity 0 to 600 amp.

The "Missing Link" starts the arc automatically without the electrode coming into contact with the work.

Descriptive literature will be sent on request to the **Mid-States Equipment Co.,** 2137 S. Wabash Ave., Chicago.

» «

These work gloves were designed especially for women workers.

Gloves for Women

★ **Industrial Gloves Co.,** Danville, Ill., recently perfected a flexible, comfortably fitting general purpose woman's **work glove.** This new glove—No. 14640—is made of light weight horsehide in small, medium and large sizes. An open back provides coolness, and an elastic web band across this opening keeps glove snug fitting. An extra thickness of leather is provided on the thumb and first two fingers, and a 2 in. leather band gives protection to the wrist. These gloves may be purchased in pairs, all rights, all lefts or any combination of rights and lefts to the dozen pairs without additional cost.

(*Continued on page 56*)

MATERIAL		A.S.T.M.	A.S.M.E. (Boiler)	C. Max.	Mn. Max.	Si. Max.	Cu. Min.	Tensile Kips Min.	Yield Point Kips Min.	Elong. in 2" % Min.	Red. in Area % Min.	REMARKS
Structural	Bridges, Buildings	A7-39					.20	60/72	0.5 T.S. 33 min.	22		Rolled Steel Base Plates Over 2" in Thickness C-0.20/0.35%
	Mild Steel	A10-39					.20	55/65	0.5 T.S. 30 min.	24		
	Locomotives	A113-39					.20	55/65	0.5 T.S.	22		T.S. for Cars 50/65
	Silicon	A94-39				.20 min.		80/95	45	(1)	30	
	Ships	A131-39						60/72	0.5 T.S. 33 min.	22		
Boiler Steel	Locomotives Flange	A30-39			.30/.60			55/65	0.5 T.S.	(2)		A30-39 (Firebox), Plates under ¾", Mn.30-.50%; C-0.25%
	Firebox (Grade A)			.30	.30/.60			52/62	0.5 T.S.	(3)		T.S. 48/58 Grade B
	Stationary	A70-39	S-1									
	Flange				.80			55/65	0.5 T.S.	(4)		A70-39, Plates ¾" and under C-0.25%
	Firebox			.30	.80			55/65	0.5 T.S.	(5)		
	High Tensile	A212-39										
	Grade A			(6)	.90	.30		65/77	0.5 T.S.	(5)		A212-39 Plates 4½" and under.
	Grade B			(6)	.90	.30		70/82	0.5 T.S.	(5)		
	Iron Plate	A129-39	S-25									
	Type A			(7)	(7)	(7)		44	27.5	25 (8")		
	Type B						.40	44	27.5	25 (8")		
	Type C						.20	44	27.5	25 (8")		
Steel for Welding	Flange and Firebox Grade A	A89-39	S-2	(8)	.35/.60			45	0.5 T.S. 24 min.	(9)		
	Grade B			(8)	.35/.60			50	0.5 T.S. 27 min.	(9)		
	Structural Quality	A78-40										
	Grade A			(8)	.35/.60			45	0.5 T.S. 24 min.	28 (8")		
	Grade B			(8)	.35/.60			50	0.5 T.S. 27 min.	25 (8")		
Wire for Concrete Reinforcement		A82-34						80	0.8 T.S.		30	
Iron and Steel Chain	Crane, Proof	A56-39			.06							See Specifications for T.S. and Elong. Tests on Finished Chain
Steel Tubes and Pipe	Fusion Welded	A139-39										8" to 30" Diameters
	Grade A							48	30	30		
	Grade B							60	35	25		Also Hydrostatic Test
	Fusion Welded	A134-39										30" Diam. and Over Hydrostatic Test Only
	Resistance Welded	A135-34										
	Grade A							48	30	30		
	Grade B							60	35	25		Also Hydrostatic Test
	Forge Welded	A136-34										
	Grade A				.35/.60			45	0.5 T.S. 24 min.	28 (8")		
	Grade B				.35/.60			50	0.5 T.S. 27 min.	25 (8")		Also Hydrostatic Test
	Lock Bar	A137-34						40/50	0.5 T.S.	28 (8")	50	
	Lap-weld & Seamless Steel and Lap-welded Iron Boiler Tubes	A83-40	S-17									
	Type A, Low Carbon Steel			.08/.18	.30/.60							Flattening, Flange, Crush, and Hydrostatic Tests
	Type B, Open Hearth Iron			.03	.03							
	Welded Steel Pipe	A53-40										
	A. Bessemer							50	30	18 (8")		
	O.H. or E.F.							45	25	30		
	Seamless steel pipe											Also Hydrostatic and Flattening Tests
	Grade A							48	30	35		
	Grade B							60	35	25		
High Temperature Service	Fusion Welded	A155-36										
	Grade A			.17	.30/.60			45	0.5 T.S. 24 min.	(2)		Plates ¾" and under, C-0.15%
	Grade B			.22	.30/.60			50	0.5 T.S. 27 min.	(2)		Plates ¾" and under, C-0.20%
	Grade C			.30	.30/.60			55	0.5 T.S.	(2)		Plates ¾" and under, C-0.25%
	Lapwelded & Seamless Welded Open H. Seamless	A106-41			.30/.60			45	25	22 (8")		Also Flattening and Hydrostatic Tests
	Grade A			.25	.30/.90			48	30	35		
	Grade B			.35	.35/1.00			60	35	25		
	Forged or Rolled Steel Pipe Flanges	A105-40	S-8									
	Grade I				.90			60	30	25	38	
	Grade II				.90			70	36	22	30	
Carbon Steel Castings for High Temperature Service		A95-41		.15/.45	.50 min.	.20 min.		70	36	22	30	Also Hydrostatic Test
Wrought Iron	Forgings For Locomotives and Cars, Class A	A73-39			.07			45	0.5 T.S.	24 (4")	33	
	Misc. Uses, Class B				.15			45	0.5 T.S.	24 (4")	33	
	Welded Pipe	A72-39	S-19		.05			40	24	12 (8")		Also Hydrostatic Test
Iron Castings	Grey Iron Class No. 20 to No. 60	A48-41	S-13					20/60				The Class No. Designates in Kips the Required T.S.- Transverse Tests Optional
	Grey Iron for Valves, Flanges, etc.	A126-40										
	Class A							21				
	Class B							31				Transverse Test Optional
	Class C							41				
	Malleable Iron	A47-33										
	No. 32510							50	32.5	10		
	No. 35018		S-15					53	35	18		

(1) A94-39, Elong., 2" % min. $= \frac{1{,}600{,}000}{\text{T.S.}}$

(2) A30-39 and A155-36, Elong., 8" % min. $= \frac{1{,}500{,}000}{\text{T.S.}}$

(3) A30-39, Firebox, grades A and B, Elong., 8" % min. $= \frac{1{,}550{,}000}{\text{T.S.}}$

(4) A70-39, Elong., 2" % min. $= \frac{1{,}700{,}000}{\text{T.S.}}$

(5) A70-39 and A212-39, Elong., 2" % min. $= \frac{1{,}750{,}000}{\text{T.S.}}$

(6) A212-39 Grade A, C-.33 for plates 2 to 4½"; .31 for plates 1 to 2"; .28 for plates 1" and under. Grade B, C-.35 for plates 2 to 4½"; .33 for plates 1 to 2"; .31 for plates 1" and under.

(7) A129-39 Total metalloids: C, Mn, P, S, and Si, max %, 0.10 type A, 0.25 types B and C. S, max % .040 all types; P, max %, .015 all types.

(8) A89-39 and A78-40, Grade A, C-.17, plates over ¾"; .15, plates ¾" and under. Grade B, C-.22 for plates over ¾"; .20 for plates ¾" and under.

(9) A89-39, Elongation for flange, grades A and B, $\frac{1{,}600{,}000}{\text{T.S.}}$; for firebox, grades A and B, $\frac{1{,}650{,}000}{\text{T.S.}}$.

(*Advertisement*)

Veteran Weldor Tells How to "*Make Something from Practically Nothing*"

By D. B. Rice, Amsco Welding Engineer

In an interview with "Pop" Braun, who keeps equipment in service for Weston & Brooker Company, at their quarry, Camak, Georgia, some hints were dropped which may prove helpful to other maintenance men and job weldors. This company produces a large volume of granite and the abusiveness of shot granite on excavating equipment is well known.

When the writer stopped in, "Pop" was making a final inspection of a dipper he had been working on. "What are you doing to this one?", he was asked.

"Taking a crack at the Japs," said Pop, "by making something out of *almost* nothing. We had this old dipper, which had been held for a spare, and I figured that if we could build it up so that it would be serviceable, it would do the job until the Japs were licked and then we could get a new one."

"Pop" reported that the dipper was badly worn all around, but that there were no real cracks in it. He used this method:

Short pieces of molybdenum-manganese steel filler bars—both round and square, were tacked on along the edge of the worn down lip and Amsco Nickel Manganese steel rod (now replaced by V-Mang molybdenum-manganese steel rod) applied to fill in around the bars and to round out the shape. (See A204.)

The space between the teeth was built up similarly. Where the lip is thick and much metal had worn away, "Pop" used a piece of manganese steel cut from scrap to make a "backer." This was welded in place, providing the preliminary shape and several round filler bars were placed on the outside to make up the thickness and for reinforcement. Built up in this way, you have a lip that "can take it," to quote Mr. Braun, "provided, of course, that you use a good rod like Amsco's."

"Pop" tacked a filler bar on the edge of the outside tooth bases, as shown (A286), to protect the rest of the tooth bases, retarding wear at that point. It is easy to do, almost a ready-made job because of the rounded edge, and does not cost much, he reports.

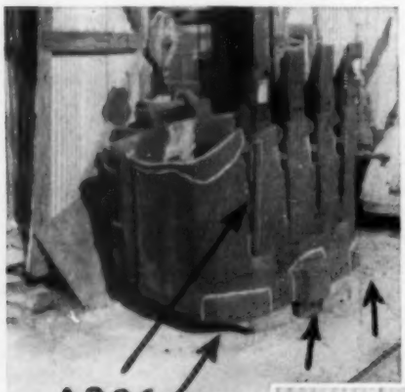
Note how the heel has been built up at the corners. Four or five round or square bars are bent cold, tacked on, and welding rod filled in between so as to present a good heavy pad to take the wear. The latchkeeper was built up similarly.

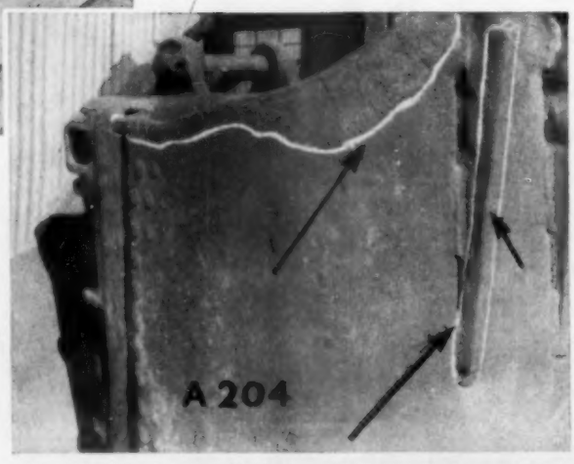
Wear was almost unnoticeable on a dipper salvaged in the same manner, which had been in service nearly seven months.

When asked if he used Amsco Hard Surfacing Welding Rods, "Pop" stated:

"We don't use them much here because the stone is hard enough to work-harden the manganese steel so that we get mighty good wear from it. In handling softer, more abrasive stone, I would use some kind of hard facing, like Amsco Economy."

Thanks, "Pop" Braun, maybe this information will enable other weldors to "take a crack at the Japs" by making present equipment, subject to impact and abrasion, last longer through the application of Amsco Reclamation and Hard-Surfacing Materials.





Bulletin 941-W pictures parts used in many industries that can be "made to do" by salvage welding.

Amsco

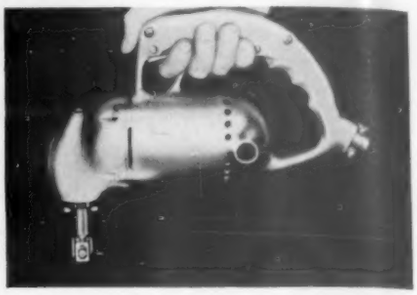
AMERICAN MANGANESE STEEL DIVISION
OF THE AMERICAN BRAKE SHOE & FOUNDRY CO.
Chicago Heights, Illinois

Manganese Steel Castings for shocks and abrasion.
Chromium-Nickel Alloy Castings for heat and corrosion resistance.
Power Shovel Dippers. Dredge and Industrial Pumps.
Welding Materials for reclamation and hard-surfacing.

FOUNDRIES AT CHICAGO HEIGHTS, ILL.; NEW CASTLE, DEL.; DENVER, COLO.; OAKLAND, CALIF.; LOS ANGELES, CALIF.; ST. LOUIS, MO. OFFICES IN PRINCIPAL CITIES

New Product Developments

(Continued from Page 52)



The No. 16 "Lectro-Shear," which cuts up to 16 gauge sheet steel.

Electric Shears

★ **Black & Decker Mfg. Co.,** Towson, Md., has re-designed both its 16 gauge and 18 gauge **"Lectro-Shear"** to improve ease of handling and operating characteristics.

No. 16 "Lectro-Shear," which cuts up to No. 16 ga. sheet steel, has been equipped with an improved operating handle shaped for finger grip at either the tool end or the rear end. Trigger switch is provided with a locking pin to facilitate continuous operation.

No. 18 model has been reduced in outer dimensions so that the motor housing forms a comfortable operating handle. This tool cuts up to No. 18 ga. sheet steel.

» «

Spot Welders

★ **Progressive Welder Co.,** Detroit, announces a line of **rocker-arm spot welding machines** for either foot, compressed air or motor operation which are available in 48 models with four capacities—20 ,30, 40 and 50 kva. Throat depths range from 12 to 36 in.

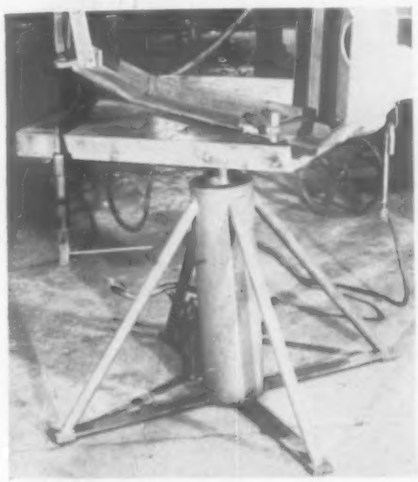
In the lowest-cost foot-operated type, the pressure is obtained through a foot

A new line of 48 rocker-arm resistance welders will meet a wide range of requirements.

pedal connected to the rocker arm by a system of mechanical links. Air-operated types have a single acting cylinder with piston rod connected to the rocker arm. Motor-driven types are equipped with a ½ hp motor, which operates the rocker arm through a Reeves variable speed drive (1 to 3 variation) and worm reduction gear and cam.

All models are equipped with an eight-stage heat regulator quickly adjustable from the rear of the machine. A wide selection of timers and contactors, both mechanical and full-electronic, is available at extra cost.

» «



This table is elevated and lowered hydraulically, by foot-pedal operation, and may be turned as desired on a full-circle pivot.

Elevating Table

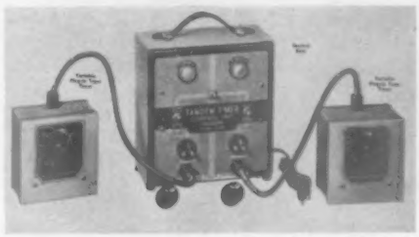
★ The Lyon **Hydraulic Elevating Welding Table** will function as a comparatively inexpensive welding positioner in instances where work is not to be raised more than 14 in. Table has a full 360 deg revolving top and may be loaded to a capacity of 2,000 lb. Platform standard stock size is 30 by 30 in., lowered height 26 in., elevated height 40 in. The operator can keep the work at the most convenient welding height by means of a foot-operated hydraulic pump, and the work may also be turned to the most convenient position. Table is portable, although it is mounted on a floor base instead of casters.

This unit is also built in other capacities or dimensions as required. A descriptive leaflet (Circular No. 129) may be obtained from **Lyon-Raymond Corp.**, 221 Madison St., Greene, N. Y.

» «

Timer

★ The **"Tandem Timer"** is essentially a control unit with two individual and variable plug-in type timing elements. When these are adjusted to the desired time intervals, each cycle of operation will follow the other continuously in regular sequence. Once time dials have been set, no further adjustments are necessary until a new sequence is required. Six standard models are available, offering settings ranging from ¼ sec to 2 hr, 45 min. Longer time cycles may be built to specifications.



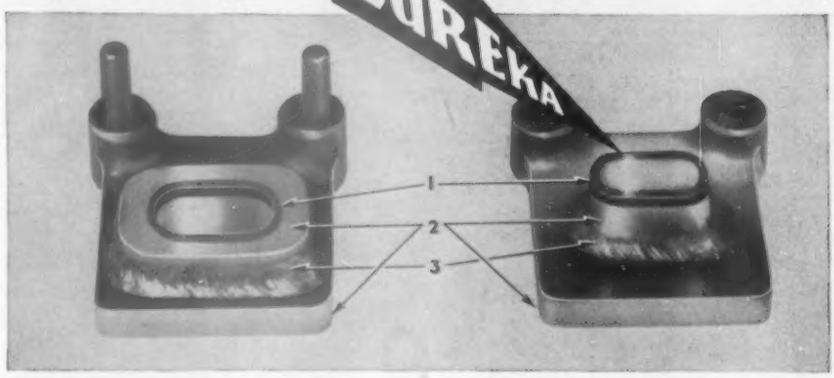
The automatic reset feature of this new timing device makes continuous, as well as a single cycle, operation possible.

Control cabinet measures 8½ in. by 8½ in. by 5 in. and contains repeat and single cycle switches, pilot lamps and sockets for the two synchronous-motor-driven, automatic resetting timers. **Industrial Timer Corp.**, 113 Edison Place, Newark, N. J.

Here's an Opportunity..

to CONSERVE TOOL STEEL

by using EUREKA ELECTRODES



Yes—it's being done every day. Tons of tool steel and alloys are being saved by welding worn or fractured dies with Eureka Electrodes and the use of a vast amount of like material is being eliminated by welding on the working edges of less expensive and more easily procurable carbon steels.

HERE'S HOW IT'S DONE

Illustration shows typical fabricated dies. Arrows 1 point out tool steel electrode deposits used as cutting edges, neither of which are over 3/16 inch thick. Arrows 2 indicate machine steel used instead of tool steel to lower die composition cost, and 3 refers to construction welds made of mild steel rod to hold die parts together.

We would like you to have our bulletin which describes and illustrates in detail the application of this new type of electrode. Send for it now!

WELDING EQUIPMENT and SUPPLY COMPANY

221 LEIB ST., DETROIT, MICH.

News of the Industry

Those in our Nation's Armed Forces may continue to read The Welding Engineer at the special reduced price of $1.50 per year for the duration.

» «

Accent to Be on War at 1942 AWS Meeting

The twenty-third annual meeting of the American Welding Society, to be held Oct. 12 to 15, inclusive, at the Hotel Cleveland, Cleveland, should prove of vital concern to everyone connected with the building of war equipment because of the essential part that welding is playing in the construction of tanks, guns, ships and other phases of armaments.

This meeting, it is pointed out in the Society's advance publicity, will provide an unparalleled opportunity to find out about the newest developments and latest advances in welding equipment, procedures and techniques, and may be the means of solving many problems in connection with the speeding of war production.

Instead of the usual weekly session, the entire program has been condensed into four days, dispensing with several of the customary entertainment and social features. Fifty-seven technical papers will be presented, covering the important phases of such timely topics as the training of weldors, fatigue and impact strength of welds, weldability of steel, aircraft welding, flame-cutting in steel mills, newest developments in resistance welding, production welding in war industries, non-destructive tests and inspection.

Full details of this powerful and meaty program will be carried in the October, 1942 ("Metal Show Number") issue of THE WELDING ENGINEER.

» «

Williams Elected President Radium and X-Ray Society

John H. G. Williams, metallurgist, Hartford Electric Steel Corp., Hartford, Conn., was elected president of the American Industrial Radium and X-Ray Society during its second annual meeting, held the week of June 22 at Atlantic City. Other officers of the Society are:

M. B. Evans, Jr., vice-president; Mr. Evans is director of industrial X-ray, Ternstedt Mfg. Div., General Motors Corp., Detroit.

Philip D. Johnson, secretary; Mr. Johnson is technical adviser, Radium Chemical Co., Inc., Chicago.

Joseph A. Catanzano, treasurer; Mr. Catanzano is technician, Thomson Laboratory, General Electric Co., Lynn, Mass.

» «

New ASTM Officers

Prof. H. J. Ball, Lowell Textile Institute, Lowell, Mass., was elected president for 1942-43 at the 45th annual meeting of the American Society for Testing Materials. **P. H. Bates,** chief, Clay and Silicate Products Div., National Bureau of Standards, Washington, D. C., was elected vice-president.

» «

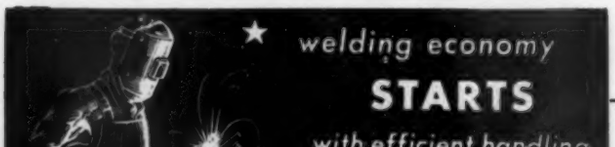
Issue New Magazine, "Industrial Radiography"

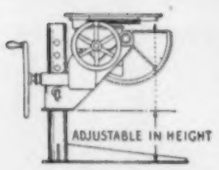
With articles devoted exclusively to metallographic inspection by X-ray and gamma ray methods, Vol. 1, No. 1 of *Industrial Radiography* made its appearance last month. The new magazine is to be published quarterly as the official journal of the American Industrial Radium and X-Ray Society, Inc.

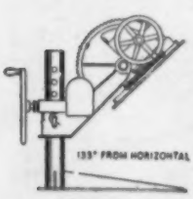
Philip D. Johnson, technical adviser, Radium Chemical Co., Inc., Chicago, and recently re-elected secretary of the Industrial Radium and X-Ray Society, is editor of *Industrial Radiography*. Assistant editors are M. J. Lieber and T. B. Jefferson, editor of THE WELDING ENGINEER. Publication offices are at 25 East Washington St., Chicago.

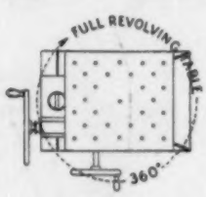
» «

Lincoln Electric Co., Cleveland, recently awarded service pins to 206 veteran employees with tenures of service ranging from 10 to 35 years. Oldest service records—both extending over 35 years—were those of **James F. Lincoln,** president and general manager, and **J. C. Lincoln,** chairman of the board and treasurer. Both of these executives were presented with service pins.









AFTER a welding assembly is once fastened to the table of a C-F Welding Positioner, the welder, without any other help, can tilt the work to any angle from horizontal to 135° beyond horizontal and he can turn it to any degree within a complete circle. This means better welds all "down hand," safer handling and faster production. Sizes from 1,200 to 14,000 lbs. capacity are described in our booklet WP 22. Write for your copy. It tells the complete story.

CULLEN-FRIESTEDT CO.,
1309 S. KILBOURN AVE. CHICAGO, ILLINOIS

Sciaky Welder Demand Necessitates New Plant

Sciaky Brothers last month moved to new **and larger quarters at** 4915 West 67th St., Chicago. This new location will house the firm's general offices and manufacturing facilities. As increased production is now possible, it is planned to broaden the present line of Sciaky welders for spot and seam welding aluminum with machines for all weldable metals.

The Sciaky process of stored energy spot welding coupled with a variable-pressure cycle was fully described in THE WELDING ENGINEER, August, 1940. Equipment of this manufacture is now being used by practically every major producer of military aircraft in the United States.

» «

Payroll Savings Plan

The U. S. Treasury Department has made available a complete set of promotional materials for every business firm that wishes to use them in achieving the goal of 10% of payroll invested in **War Savings Bonds.** This material includes a book outlining the basis for the campaign, another booklet explaining the plan in detail, a booklet for the employee stressing practical benefits each worker will gain by having a reserve fund saved up for the post-war years, and three small envelope stuffers to be distributed via the pay envelope.

» «

Krembs & Co., Chicago, has appointed Universal Power Corp., 4300 Euclid Ave., Cleveland, as distributor of "Fluxine" fluxes, "Kop-R-Arc" welding rods and other Krembs welding products in the Northern Ohio territory.

Personals

George H. Bendell has been appointed superintendent of factories at Joliet, Ill., Works, American Steel and Wire Co. At the same time **Henry W. Spitzhoff** has been named superintendent of the wire mill at Joliet.

» «

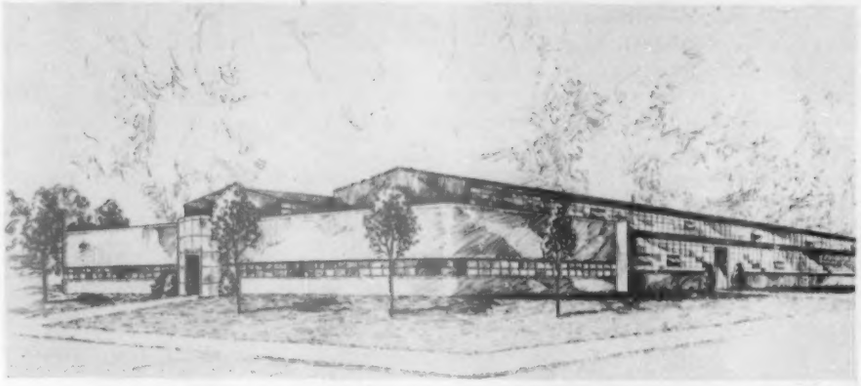
James F. McNamara, mill products sales manager of The International Nickel Co., has been made chairman of the board of directors of the **Harvill Aircraft Diecasting Corp.**

» «

J. J. Boughey has been appointed district supervisor of safety of the **Carnegie-Illinois Steel Corp.** Mr. Boughey's former position as director of safety, South Works, will be filled by **A. D. Sweeney,** formerly a safety inspector.

» «

Arthur W. Henshaw, for several years in charge of association relationships in the **General Electric Co.,** has retired after having completed 46 years of service with General Electric.



Sciaky Brothers' new factory near the Chicago municipal airport.

Welder Maintenance

(*Concluded from page 47*)

Improper connection of extension leads for either the electrode or work terminals is not at all uncommon. This results in a high resistance circuit from welder to arc and return with resulting variations in welding current, particularly when the leads are moved so as to change the resistance of the connections. This is a frequent cause of complaints by weldors that the heat is not steady. The remedy for this is to make sure that connections are kept tight, and that all connections are made with cables equipped with properly installed cable lugs or terminals. It is practically impossible to bolt or wedge untinned flexible cable to another conductor and secure a good low resistance joint. Soldered or reliable solderless connectors or terminals should always be used.

The use of excessively long electrode or work leads with motor-generator type welders will result in overheating of the motor when operating in the upper part of the current range unless extraordinarily large cables, or a number connected in parallel, are used. Overheating of the motor from this cause is a frequent reason for motor-generator welders tripping off the line with consequent loss of production.

Short Circuit Troubles

A source of trouble which is not protected against by the motor overload relays is the intentional or unintentional application of long continued short circuits on the generator. Poor cable or cable connection insulation may be responsible for unintentionally short circuiting a generator for long periods of time. This results in the flow of very heavy generator current, but because of the low generator voltage involved, does not require sufficient power input from the line to cause the motor overload relay to trip. While the motor is not damaged, the generator may be seriously overheated or burned out. The same results will follow intentional permanent short circuiting of the electrode holder on the work or any grounded conductors.

The use of improperly bonded structural steel systems or building frameworks for the welding current return circuit is undesirable. The high resistance path thus afforded the welding current may result in overheating of the welder motor, and in addition, there is always the possibility that arcing or overheating of some poor connection, possibly quite remote from the scene of operations, may go unnoticed and start a fire.

No attempt should be made to adjust welding current output by any means other than those provided and recommended by the manufacturer of the equipment. Shifting the brushes on generators not designed for brush-shifting control will usually result in inferior welding characteristics, impaired commutation, and short brush life. Short circuiting of resistors or rheostats or any other tampering with the control furnished on arc welding equipment may result in damaging or burning out the equipment.

In transporting welding equipment, rough handling resulting in permanent mechanical damage is all too frequent. Motor-generator sets mounted on steel wheeled running gear should be moved only at slow speeds — never behind fast-moving trucks or other vehicles. They should be eased over obstacles and depresions such as flange clearance grooves in tracks. Slings used for transportation of welders by crane should be carefully arranged to avoid damaging control boxes, handles, and other equipment mounted on the outside of the set.

Above: Tuerff's Hobart welder in action cutting parts of car.

Inset: Shows belt driven Pierce Flyball Governor on the Chrysler Industrial Engine.

YOU CAN DO IT BETTER WITH PIERCE ON THE JOB!

HOW TO MAKE YOUR GOVERNORS LAST!

Like others manufacturing for war needs, Pierce production is for war and essential industry. For this reason new governors can be supplied only on a priority basis. But Pierce calls attention to these easy measures which will make your present Pierce Governors last and give the best service.

- **CLEAN GOVERNORS** once a month with kerosene, gasoline, or prepared cleaner.
- **INSPECT AND CHECK GOVERNORS** each week when in continuous operation.
- **CHECK OIL LEVEL** every day in manually lubricated governors. SAE 20 Oil is recommended at this time of year.
- **LINE UP** driving pulleys or gears accurately when reassembling governor after cleaning.

Should your governor need repair or reconditioning send it to the factory with the necessary preference rating certificate.

● "The Pierce Flyball Governor on the Chrysler Industrial Engine of our Hobart welder gives the close, sensitive regulation we want for both welding and cutting," says Chris Tuerff, head of Tuerff's Machine Shop, Anderson, Indiana. "Its action is positive and reliable and it gives fast recovery of current characteristics after striking arc for good, strong welds."

* * *

Pierce Flyball Governors are precision-built speed-regulating instruments proven under most exacting conditions in the field. That's why Pierce Flyball Governors are standard equipment on most engine driven welders.

THE PIERCE GOVERNOR COMPANY
1607 Ohio Avenue, Anderson, Indiana

Pierce Governors
STANDARD SINCE 1913

Care should be taken to avoid using arc welders out-of-doors in unfavorable weather. Many machines now on the market are designed to be both semiprotected and dripproof. This does not mean, however, that these welders should be used in rain or other precipitation without suitable protection.

At the discretion of the user, of course, dripproof or even open motor-generator sets can be operated out-of-doors, provided they are protected from obviously damaging conditions by tarpaulins or temporary shelters. These must be arranged so as not to hinder ventilation of the equipment, as previously discussed.

Troubles and Remedies

In spite of the reliability of the modern arc welder, troubles will occur. The causes and remedies for the majority of such troubles are given in the following tabulation:

Trouble

Machine fails to hold heat.

Causes

Rough or dirty commutator.
Brushes may be worn down to limit of adjustment or life.
Brush springs may have lost adjustment or may be broken.
Field circuit may have variable resistance connection or intermittent open circuit.
Electrode lead or work lead connections may be poor.
Wrong grade of brushes may have been installed on generators.
Field rheostat or tap switches may be making poor contact and overheating.
Brush-shifting or other mechanical current-adjusting mechanism may have loose or worn links.

What To Do

Commutator should be trued or cleaned.
Replace or readjust brushes.
Replace or readjust brush springs.
Check field current with ammeter to discover varying current. This applies to both the main generator and exciter if used.
Tighten all connections.
Check with manufacturers' recommendations.
Inspect rheostat and clean and adjust finger tension on switches.
Check current-adjusting mechanism for backlash and play.

Trouble

Motor trips off line.

Causes

Power circuit may be single-phased.
Welder may be operating above current capacity.
Welding electrode or work leads may be too long or too small in cross section.
Ambient temperature may be too high.

What To Do

Check for one blown fuse or dead line.
Check load against welder nameplate. Check duty cycle.
Check terminal voltage while machine is loaded; it should not exceed 30 v on small machines or 40 v on large machines when operating at rated current.
Make sure that temperature in motor-generator room or housing does not exceed 100 F and that there is no interference with normal ventilation of the machine.

Trouble

Machine fails to start.

Causes

Power circuit may be completely dead.
Power circuit may be single-phased.
Power line voltage may not be suitable for motor, or may be extremely low; may be accompanied by chattering of the motor starter.
Machine may be jammed.
Motor starter may be single-phased.
Overload protecting relays may be tripped.

What To Do

Look for open disconnect switch, fuses removed from clips, or blown fuses.
Look for one blown fuse or one dead line.
Check voltage with voltmeter, particularly at the moment of attempted starting.
See that armature turns over easily by hand, and look for foreign material in air gaps.
Check to see that all fingers on starter make contact when closed.
See that relay contacts are closed and that starter picks up when push button is pressed. Be sure to remove cause of tripping.

Trouble

Welder starts but fails to generate.

Causes

May be running the wrong way.
Generator or exciter brushes may be loose or missing.
Exciter may not be operating.
Field circuit of generator or exciter may be open.
Generator may be reversed in polarity due to another machine or incorrect operation in parallel with another machine.
Series field and armature circuit may be open-circuited.

What To Do

Check direction of rotation with manufacturers' instructions or direction arrow. On 3-phase motors, direction of rotation may be changed by interchanging any two leads.
Be sure that all brushes bear on the commutator and have proper spring tension.
Check exciter output voltage with voltmeter or lamp.
Check for open circuits in rheostat, field leads, and field coils. Also check resistors and rectifiers, if any. Some machines give low output when fields are open.
*Flash the field with a storage battery or another generator first with one polarity and then with the other to see if it builds up. (Flash exciter field if set has separate exciter.)
Check circuit with ringer or voltmeter.

Trouble

Welding arc is loud and spatters excessively.

Causes

Current setting may be too high.
Polarity may be wrong.

What To Do

Check setting and current output with ammeter.
Check polarity.
Try reversing polarity or try an electrode of the opposite polarity.

*"Flashing" the field of a generator or exciter is a method of establishing the residual magnetism of the field structure with the proper polarity to cause the machine to "build-up," or generate voltage. It consists of passing a relatively heavy current through the field windings momentarily, using an external source of direct current to supply the power.
If a low-voltage source, such as a storage battery, is used, the series field of the generator should be flashed; if a higher voltage source such as another generator or exciter is used, the shunt field should be flashed.

Know why so many SKILSAW DISC SANDERS are used in War Production plants? The answer's simple—these more powerful, easier-handling tools *are faster!* They grind down welding beads, remove fins and scale, file, sand, buff and polish on metal, wood, stone, tile and compositions. That's why SKILSAW DISC SANDERS are *preferred* in aircraft, tank and War plants everywhere . . . to make every man and every minute count *for more!*

6 POWERFUL MODELS for all finishing on flat or curved surfaces . . . for use with grinding wheels, sanding discs, rubbing pads, wire brushes and polishing bonnets. Ask your distributor to demonstrate SKILSAW DISC SANDERS on your toughest surfacing jobs.

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SKILSAW PORTABLE ELECTRIC TOOLS
★ MAKE AMERICA'S HANDS MORE PRODUCTIVE ★

Current Reviews

Aircraft Bulletin

"How Aircraft Designing Engineers Use Ampco Metal" is an 8-page, letterhead-size bulletin, being distributed by **Ampco Metal, Inc.**, Milwaukee.

The booklet describes pictorially the use of Ampco Metal by the aircraft industry. Printed in two colors, it is well illustrated with photographs of a wide variety of aircraft and equipment. Copies of the new bulletin will be sent to interested engineers.

» «

Spectrum Chart

A new seven color **wall chart** of the entire electro-magnetic spectrum has been recently published by the Westinghouse Research Laboratories and may be obtained by sending $2 to Publications Section, 6-N-17, **Westinghouse Electric & Mfg. Co.**, East Pittsburgh, Pa.

The chart measures approximately 30 by 40 in., is printed on heavy white cloth and is bound at top and bottom by 3/8 in. enameled wooden rods. It analyzes in detail every part of the electromagnetic spectrum, placing special emphasis upon the uses for each kind of radiation. Spectral terms are defined in a special glossary.

» «

Tool Salvage Suggestions

As a contribution to the war effort, **Eutectic Welding Alloys, Inc.**, 40 Worth St., New York City, has printed a **special folder** devoted exclusively to the salvaging of tools and machine parts by means of low temperature welding. Suggested procedures and recommended alloy rods are given for welding tool steels, for building up worn parts of both ferrous and nonferrous metals, for welding cast iron, for brazing, for welding aluminum and magnesium.

» «

Seam Welder Bulletin

Technical and descriptive Bulletin No. 801WE, covering its new line of standardized seam welders, has been released by **Progressive Welder Co.**, 3050 E. Outer Drive, Detroit. The bulletin covers design and operating features of light, medium, and heavy duty seam welders which are available in three styles — for transverse welding, for longitudinal welding, and for both types.

Diagrams of the three types of drives available for these machines, as well as illustrations of typical applications are included. Specifications tables and drawings showing major dimensions of the standardized machines are provided. Copies of the Bulletin are available directly from Progressive Welder or through this publication.

» «

"The Hobart Group"

The above title refers to a 20-page, three color **booklet** which explains with print and pictures the products, manufacturing and engineering facilities and wartime activities of the companies making up the Hobart Group of factories. The book is carefully laid out and attractively printed; it tells an interesting story of "lines of duty" for America's defense. **Hobart Brothers Co.**, Troy, O.

» «

Fire Extinguisher Poster

A three color **poster** showing the correct method of using fire extinguishers of the carbon dioxide, water-and-foam and vaporizing liquid types may be obtained without charge from **Walter Kidde & Co., Inc.**, 140 Cedar St., New York City. This poster was designed for display in industrial plants in order to acquaint workers with the best methods of fighting fires of either accidental or incendiary origin. The kinds of fires for which each of the three major extinguisher types should be used are stated concisely, and the methods of operation simply and clearly explained through pictures and brief captions.

» «

A-C Welder Bulletin

Welding Apparatus Co., 2750 West Van Buren St., Chicago, has issued a four-page folder describing its equipment for "Positive Arc" **A-C Arc Welding.** Advantages claimed for welding by this process are current adjustment in steps from one amp to the upper limit of the current range and instant arc ignition, due to a superimposed high frequency circuit.

Saved: month's loss on A-1-a orders

2-ton Section of 100" Boring Mill Goes Back on Job After Speedy "997" Repair Weld—Only 39 Man Hours for Chipping, Grinding and Welding

Score another production victory for repair welding. This huge section for a boring mill working exclusively on A-1-a priority business was "down" for an unusually short time, despite its severe damage.

The Hebeler Welding Company of Buffalo, repair welding specialists, provided the way to give our war program the use of this mill with a minimum delay . . . repair welding with Anaconda 997 Low Fuming Rod.

75 pounds of this bronze welding rod were used, 600 feet of air and gas were consumed and 39 man hours required for the chipping and welding which put the mill in shape for active service.

4298A

For vital jobs like this one, Anaconda 997 Low Fuming Welding Rod, Tobin Bronze and other Anaconda Welding Rods are always "on call".

The trade-marks "Anaconda" and "Tobin Bronze" are registered in the U. S. Patent Office.

ANACONDA

Anaconda Welding Rods

THE AMERICAN BRASS COMPANY, General Offices: Waterbury, Connecticut

Subsidiary of Anaconda Copper Mining Co. • In Canada: Anaconda American Brass Ltd., New Toronto, Ont.

"Super Sight" Catalog

Just released by **The Boyer-Campbell Co.**, 6540 Antoine St., Detroit, is a four-page **catalog** of equipment combining magnification with properly directed light. "Super Sight," as this product is known, may be used for close inspection, fine assembly, precision machining, more accurate readings of verniers, height gauges, micrometers and other finely graduated tools.

A supplementary folder titled "Super Sight" describes this principle of properly directed light plus magnification as adapted to First Aid and hospital use.

» «

Folder on Eye Drops

"Welder's Pal" eye drops are described in a circular published by **Carhoff Co.**, 3050 Kensington Road, Cleveland. These eye drops, which have been on the market for over seven years, were developed especially to ease eye irritations from which weldors may suffer.

» «

Office Supply Report

One way to help in the present war effort is by concentrating on the conservation of office supplies and equipment. The procedures employed by a number of companies to inaugurate or intensify existing waste reduction programs are outlined in a recently issued report. This report is called "Wartime Conservation in the Office" and is available to executives who write on their business stationery to: **Policyholders Service Bureau, Metropolitan Life Insurance Co.**, One Madison Avenue, New York City.

» «

Silver Alloy Brazing

A technical article on **"Silver Alloy Brazing of Fabricated Copper Piping"** by J. C. Powers, Jr., and H. DeM. Lucas, sales engineers of **Handy & Harman**, 82 Fulton St., New York City, has just been published by this concern as an 8-page pamphlet. Article describes the procedure in detail, tells fully of the inside feed and outside feed methods of heating and applying the alloy, discusses specialized applications such as the brazing of branch outlets and flanges to fabricated copper pipes, brazing of low hub flanges to fabricated pipes and the brazing of circumferential rings on expansion joints.

Recent Patents

Metal Spray Gun

2,287,770. **Frans O. Albertson**, Sioux City, Ia., assigned to **Albertson & Co.**, Sioux City. Filed Jan. 11, 1939. Issued June 30, 1942. A spray gun for metal having a nozzle for metal and air nozzle unit. The latter comprises a metal tube for connection to an air conduit with air nozzle having a narrow, arcuate aperture at the opposite end. A metal alignment block is located in a predetermined longitudinal position on the tube for determining the spacing of the air nozzle from the metal nozzle; this block has shoulders which engage complementary shoulders on the gun and thus determine the rotative position of air nozzle and tube with respect to the metal nozzle.

» «

Stud Welder Gun

2,287,818. **Edward F. Nelson**, Vallejo, Calif. Filed May 31, 1940. Issued June 30, 1942. This patent pertains to the combination of a welding head for carrying a first metallic member to be welded to a second metallic member, the means for positioning the welding head relative to the second metallic member, and a single self-propelling element in the welding head which moves the first metallic member in a cycle from and toward the second member.

» «

Multiple Spot Welder

2,287,945. **Hugo Purat**, Detroit, assigned to **Progressive Welder Co.**, Detroit. Filed March 6, 1940. Issued June 30,

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Type BX
(Patented)

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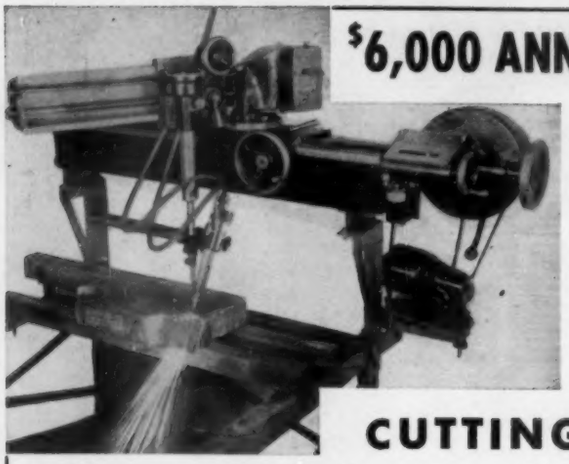
Detroit, Michigan

In Canada: C. H. Henze Co., Windsor; Holiup Corporation, Limited, Toronto; Leavitt Safety Appliances Co., Toronto; Paragon Supplies, Limited, Vancouver; Flecks Bros. Limited, Vancouver.



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√ Avoids Delays
√ Reduces Costs

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Vee Block—2 hrs. to 7 min.
Stripper Plate—5 hrs. to 15 min.
Bolster Plate—4½ hrs. to 11 min.
Heel Clamp—2 hrs. to 6 min.
Gear Blank—3½ hrs. to 7 min.
Die Shoe—5 hrs. to 14 min.

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OF WELDED PIECES

Where quantities of similar pieces are to be welded, time savings range up to 50% and beyond when Ransome Positioners are used.

The T-slotted table top is first jigged-up and the welder is then prepared to weld one piece after another with little lost time in changing pieces, less rod waste, better welds and more production. Write for complete information.

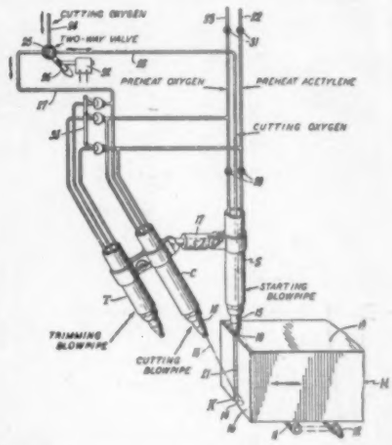
INDUSTRIAL DIVISION
RANSOME CONCRETE MACHINERY COMPANY
DUNELLEN **NEW JERSEY**

1942. A resistance welding machine with a plurality of electrodes for engaging the work. Fluid-operated switches connect the electrodes to the welding current. The switches are connected to the source of fluid pressure in succession, the means for connecting being operated by a fluid pressure motor. Motor speed is regulated by a valve and may be varied to control the length of time to which electrodes are connected to the current source.

» «

Flame-Cutting Machine

2,288,026. **John A. Rea**, Shaker Heights, O., assigned to **The Linde Air Products Co.** Filed May 31, 1940. Issued



June 30, 1942. This patent pertains to the performing of a metal-removing operation by applying a stream of oxidizing gas to successive portions of a surface of a ferrous metal body along a path beginning at the surface. This method provides improvement which comprises quick heating of the surface with a gas flame by projecting a separate flame-cutting starting jet toward and along the surface from an edge. After the starting jet has heated a strip of the ferrous metal body to an incandescent temperature, the main stream of oxidizing gas is turned on to start the main metal removing operation.

» «

Multiple Spot Welder

2,288,032. **William E. Smith**, Detroit, assigned to **The Midland Steel Products Co.**, Cleveland. Filed Dec. 17, 1940. Issued June 30, 1942. This patent pertains to a means for clamping work in fixed position in a spot welding machine and to a welding head capable of welding in three directions. A means is provided for moving the welding head lengthwise of the work, moving it horizontally, moving it vertically and on a component of all three directions simultaneously.

» «

Electro-Brazing Equipment

2,288,348. **Russell A. Funk**, Pleasant Ridge, Mich. Filed June 10, 1940. Issued June 30, 1942. A method of brazing strands of wire to a tubular termi-

CORTLAND GRINDING WHEELS

provide LONGER LIFE plus FAST-CUTTING performance

Especially Adapted for Weld Grinding

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For STEEL, STEEL PRODUCTS, TOOLS, EQUIPMENT, MACHINERY *"Call Scully"*

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UNITED STATES STEEL

Memo:

To: Mr. John Doe . . . interested in welding

Subject: THE AMERICAN WELDING SOCIETY

Whatever branch of the art interests you most . . . arc, gas, resistance or thermit welding . . . it's to your benefit to join The American Welding Society.

Our membership includes engineers, production men, purchasing agents, draftsmen, foremen, welders, inspectors, contractors, sub-contractors, company presidents, Government officials, research men, professors, students . . . people in many industries all over the country. When you attend the first meeting of your local Section of the Society, you'll immediately appreciate the many advantages of belonging to this alert and progressive group.

Here's what the Society and its 5300 members offer you in 1942:

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The American Welding Society provides you who are interested in welding with a growing fund of data and ideas . . . any one of which may be worth many times the cost of many years' membership to you. Please write me for a free copy of our informative booklet on the Society.

J. D. TEBBEN, Chairman Membership Committee
THE AMERICAN WELDING SOCIETY
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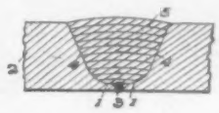
nal fitting by means of resistance welding. The steps involved are: inserting the strands of wire into the tubular fitting, deforming the fitting sufficiently to press the wires into a homogeneous mass by compressing the fitting with the wire strands therein between a pair of welding electrodes, and passing sufficient electrical current from one electrode to the other, through the fitting and the wire strands, in order to weld strands to fitting.

» «

Welding Joint

2,288,433. **Hans Nielsen Boetcher** and **John William Hudnall, Jr.**, Baltimore, assigned to the **Consolidated Gas Electric Light & Power Co. of Baltimore.** Filed Aug. 19, 1939. Issued June 30,



1942. A method of welding the ends of pipe, pipe sections, walls of pressure containers and conduits, and the like, of moderate or heavy metal thicknesses and in the absence of a backing element, where a transverse or circumferential joint is to be formed or a joint accessible from only one side. It includes the steps of shaping the edges to be welded to form protruding lips at the root which are integral and homogeneous with and formed of the same material as the entire edges to be united. These lips have a thickness approximating light gauge pipe or plate and are of a shape and thickness suitable for the butt welding of light gauge pipe or plate with substantially complete penetration to the root. Opposing extremities of lips are suitably spaced for butt welding of relatively light gauge pipe or plate with substantially complete penetration to the root. Welding is in two separate steps. First step is the butt welding of opposed lips by fusion welding, in the absence of a backing element at the joint, so that only approximately the extremities of lips are joined. Then the groove formed by the butt welding of the lips is filled with weld metal.

» «

Resistance Welding Control

2,288,567. **Charles E. Heitman, Jr.**, and **Frederic E. Laig**, Philadelphia, assigned to **Edward G. Budd Mfg. Co.**, Philadelphia. Filed March 22, 1939. Issued June 30, 1942. This patent pertains to a timer control for a resistance welding circuit. Means, including a timer control, are provided for effecting engagement under pressure of a pair of welding electrodes with work pieces, and for causing a welding current to flow through electrodes. Means at all times independent of the timer control and responsive to the flow of welding current are also provided for positively maintaining the welding electrodes under pressure during the flow of current.

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The Pug Knives shown above tell a graphic story of the unusual wear resisting qualities of COLMONOY hard-surfacing alloys and overlay metals.

1. New, 24 lb. pug knife, made of high alloy steel.
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of The

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426 N. Ashland Ave., Chicago, U. S. A.

Butt Welding Attachment

2,288,693. **Joseph A. Fotie,** Kansas City, Mo. Filed Aug. 20, 1941. Issued July 7, 1942. A butt welding attachment for use with a spot welding machine of the type including a stationary arm and a rocker arm. Spaced pairs of clamping and welding jaws are supported on the stationary arm to clamp separate work pieces and to move them relative to each other. Means are provided for transmitting current to each of the welding jaws. A mechanism moves the clamping jaws relative to each other, and a separate mechanism moves the welding jaws relative to each other. An actuator, carried by and movable with the rocker arm, operates the mechanism in timed relationship so that one operation of the rocker arm will first clamp the work pieces and thereafter bring them into welding relationship.

» «

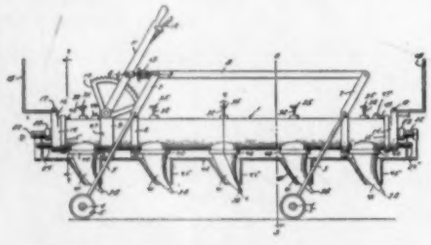
Low Temperature Brazing Alloy

2,288,869. **Rene Wassermann,** New York City. Filed Nov. 16, 1940. Issued July 7, 1942. This patent pertains to an alloy rod for welding cast iron base material at low temperature. Base material is first cleaned and preheated to a temperature of about 800 to 1400 F by applying to its surface a substantially flat horizontal oxy-acetylene flame. Welding rod is held in front of the flame and melted. Rod is substantially composed of cast iron with flux acting substance. Molten cast iron from the rod, flowing onto the preheated surface, forms a homogeneous bond with the latter.

» «

Multiple Welding Torch

2,288,888. **Wilmer W. Clark,** Spokane, Wash. Filed April 7, 1941. Issued July 7, 1942. A welding torch embodying a

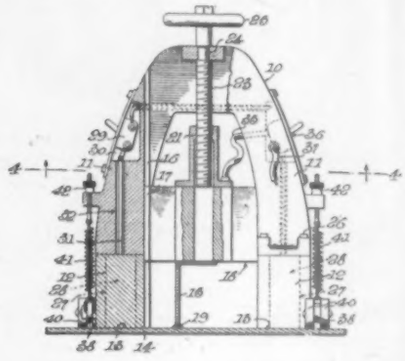


plurality of tips and parallel gas pipes to which the tips are connected at longitudinally spaced points on the gas pipes. A rotatable water jacket encloses the pipes; the jacket is straddled by U-shaped stands and embraced by collars relative to which jacket is rotatable. A manually manipulative operating connection between the bight portions of the stand permits rotating the stands in unison for bodily positioning the equipment at the desired position of adjustment relative to the work.

» «

Magnetic Welding Clamp

2,289,458. **William W. Rodgers,** Ruxton, Md. Filed Nov. 7, 1940. Issued July 14, 1942. A magnetic clamp for holding a

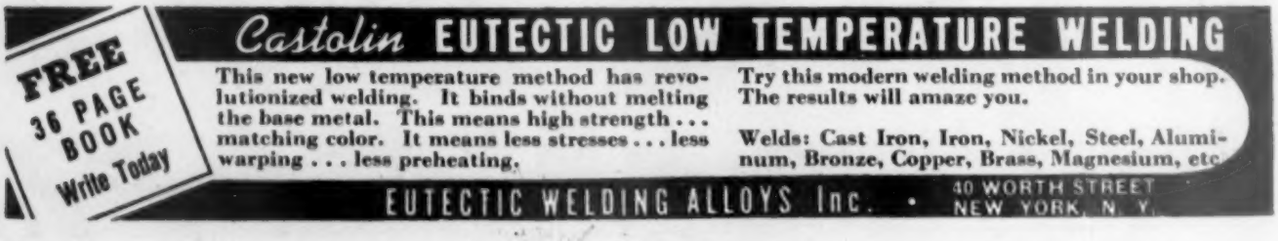


metal angle against a metal plate while connecting the two. An arched yoke has feet on its legs to rest upon the plate; these feet carry electro-magnets for anchoring them against plate. The crown of the yoke is provided with a bearing at an angle to the feet. A clamp between and slidably engaged with the legs holds the metal angle against the plate; clamp may be adjusted by means of a member engaged with the bearing.

» «

Bar Cutting Torch

2,289,786. **Homer W. Jones,** Westfield, N. J., assigned to **The Linde Air Products Co.** Filed Oct. 19, 1940. Issued July 14, 1942. A process of flame-cutting a solid ferrous metal bar by means of a thermochemical cutting medium and a jet of oxidizing gas, both of which are advanced simultaneously along a plane extending transversely to the bar. The cutting medium is directed against successive exterior surface portions of the bar along a line extending along the outside from one side of the bar to the other side, forming a kerf through the bar. The jet of oxidizing gas is directed across exterior surface portions of the bar at the successive points of emergence of the slag from the kerf while the latter is being formed.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The above unretouched photo clearly illustrates the result of Brinell tests on an actual Weld.

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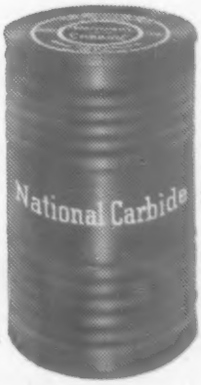

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Electrode Holder

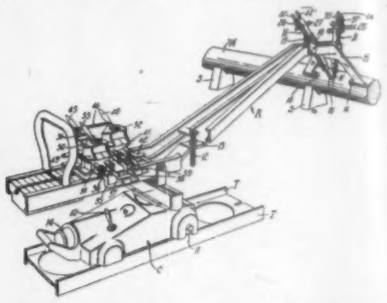
2,288,994. **Leon Del Bene,** Ridgefield, N. J. Filed Nov. 21, 1941. Issued July 7, 1942. A welding electrode holder com-

prising a tubular hand grip member of insulating material, a conductive butt block to which electric current is supplied, a conductor rod affixed to the butt block and extending axially outward through the hand grip member and a sheath of insulating material slidably engaged over the conductor rod. Butt block is affixed within the rearward end of the hand grip, free end portion of conductor rod is externally projected from the hand grip member, and sheath has its rearward end portion telescopically entered in the outer end portion of the hand grip member. Outer end portion of sheath extends beyond the outer extremity of conductor rod, and sheath and conductor rod have openings adapted to be aligned for reception of an electrode when sheath is retracted to the limit of its inward movement. When electrode has been placed, a spring thrusts the sheath outwardly; this outward movement causes the electrode to be gripped and held in electrical contact with the conductor rod.

» «

Bar Cutting Machine

2,289,968. **Everett P. Jones,** Elizabeth, N. J., assigned to **The Linde Air Products Co.** Filed April 2, 1940. Issued July 14, 1942. A method of severing a ferrous metal bar by means of a relatively low-intensity heating flame, a separate high-intensity heating flame and a stream of oxidizing gas. The low-intensity flame is directed substantially tangentially against a curved surface portion at one side of the bar. The high-intensity flame is also directed against the surface of the bar but is disposed at an angle to the direction of flow of the low-intensity flame and is in a direction substantially normal to the surface portion. When the surface reaches an ignition temperature, the high-intensity flame is replaced with a stream of oxidizing gas, but the low-intensity flame is continued. The

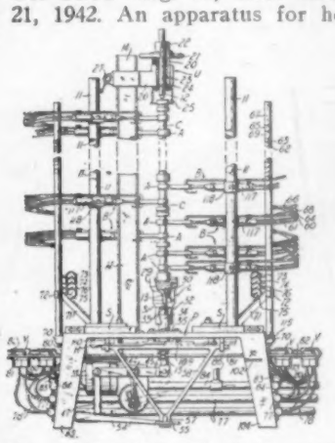


oxidizing gas stream and the low-intensity heating flame are moved simultaneously transversely across the bar to form a kerf.

» «

Flame-Hardening Machine

2,290,283. **Homer W. Jones,** Westfield, N. J., assigned to **The Linde Air Products Co.** Filed Aug. 11, 1939. Issued July 21, 1942. An apparatus for heat



treating a plurality of cams upon a camshaft by means of a plurality of torches for applying high temperature heat. The camshaft is supported by members which engage it at either end and is given reciprocating movement. A means is provided for preventing damage to the torches in case the camshaft becomes dislodged from either supporting member during reciprocation.

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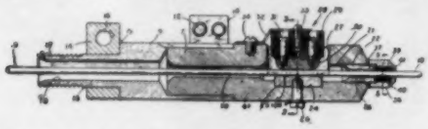
Automatic Arc Welding Head

2,289,938. **William E. Smith,** Detroit, assigned to **The Midland Steel Products Co.,** Cleveland. Filed March 27,

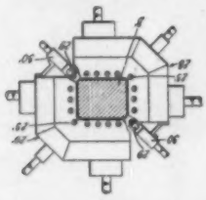


1941. Issued July 14, 1942. A metallic arc welding head comprising a member having a longitudinally extending bore through which welding wire may be passed and an insulated sleeve having a guide opening to hold the wire spaced from the walls of the bore.

» «

Flame-Cleaning Apparatus

2,290,290. **Edward Meincke,** Scotch Plains, N. J., assigned to **The Linde Air Products Co.** Filed July 27, 1940. Issued July 21, 1942. A process for flame-cleaning and conditioning of an elongated polygonal ferrous metal body having a corner extending lengthwise and longitudinal surfaces extending along each side of the corner. The process comprises progressive application of an oxidizing gas stream obliquely against successive heated

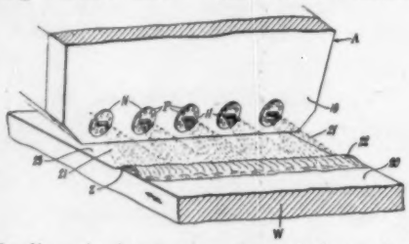


portions of corner, the stream having its longitudinal axis disposed in a plane passing through the corner and extending between the planes of the previously mentioned surfaces. Simultaneously, oxidizing gas streams are progressively applied obliquely against successive heated areas on both surfaces, the point of discharge of the corner stream being maintained slightly farther from the surface of the corner than the points of discharge of the other streams are maintained from their respective surfaces. Thus the lateral portions of the several oxidizing streams merge substantially uniformly with one another to provide a continuous oxidizing gas stream extending around the corner.

» «

Flame-Machining Method

2,290,295. **Arthur P. Scheller,** Irvington, N. J., assigned to **The Linde Air Products Co.** Filed Nov. 8, 1940. Issued July 21, 1942. A method of flame-planing surface metal from ferrous metal

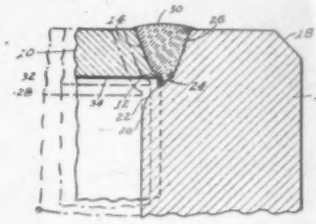


bodies. At least a portion of the metal to be removed is heated to an ignition temperature and a ribbonlike oxygen stream is caused to flow with a uniform velocity throughout its width, velocity substantially exceeding that of sound. The stream has a relatively flat bottom surface and diverging lateral sides; it is directed obliquely against and along the heated portion of the metal with its bottom surface adjacent surface of the metal body. The stream is then moved relative to the body to advance it along the surface in the direction of the metal to be removed.

» «

Welded Piping Plug

2,290,515. **James Howard Williams,** Providence, R. I., assigned to **General Fire Extinguisher Co.,** Providence. Filed July 24, 1940. Issued July 21, 1942. An end plug to be welded to a tubular element to close an opening therein. Plug is composed of a central flat portion of less diametrical dimension than that of opening, a convexly curved portion adjacent the edge of the central portion, a concavely curved portion adjacent the edge of the convexly curved portion, and a cone shaped portion extending outwardly with increasing diametrical dimension from the outer edge of the concavely



curved portion to the outermost edges of face. The flat portion of face is of such extent as to be positioned within the opening of and spaced from the inner wall of the tubular element and the remainder of the face coöperates with the end surface of the element wall to provide a groove for weld metal.

» «

Resistance Welding Timer

2,290,543. **John W. Dawson,** Auburndale, Mass., assigned to the **Westinghouse Electric & Mfg. Co.,** East Pittsburgh, Pa. Filed Oct. 12, 1938. Issued July 21, 1942. This patent pertains to a device for use in supplying power from an A-C source to a resistance welding load. The combination comprises a valve interposed between current source and load for controlling the flow of current, a first timing means for coupling to the valve, and a second timing means, also for coupling to the valve, which is provided with a switch. Energizing first timer after coupling it to the valve causes current to flow to load in form of a substantial number of discrete pulses separated by intervals of time having the same magnitude as the pulses, each pulse enduring for greater time than the period of the source. Energizing second timer, after it is coupled to valve and after closure of switch, causes current to flow to load in the form of only a single pulse, a predetermined interval of time in length, for each closure of the switch. Means are provided for coupling at will one or the other of the timers to the valve.

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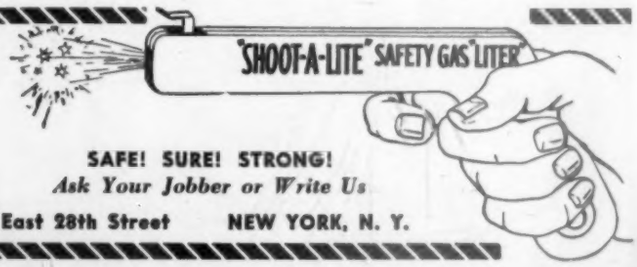

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